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MEASURES AND TRENDS U.S. AND U.S.S.R. STRATEGIC FORCE EFFECTIVENESS (U)

Santa Fe Corporation
4660 Kenmore Avenue
Alexandria, Virginia 22304

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Independently Targetable Warheads	EMT
ICBM Throwweight	Lethal Area

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

(U) The report compiles and describes the measures of effectiveness which have been used in comparisons and analyses of U.S. and Soviet strategic nuclear forces and weapon systems. For each of the measures addressed, a description of the measure is provided which also identifies the limitations and uncertainties associated with the measure. Historical trend plots are presented.

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TABLE OF CONTENTS

Table of Contents 3

List of Figures 10

List of Tables 13

CHAPTER I. SUMMARY

A. INTRODUCTION 15

1. General 15

2. Background 15

B. MEASURES OF EFFECTIVENESS 17

1. General 17

2. Traditional Indices 18

3. Other Indices 19

4. Limitations and Uncertainties 21

C. METHOD OF PRESENTATION 23

D. GENERAL OBSERVATIONS 25

CHAPTER II. THE MEASURES AND TRENDS

A. STRATEGIC NUCLEAR DELIVERY VEHICLES 33

1. General 33

a. Intercontinental Ballistic Missiles 33

b. Submarine-Launched Ballistic Missiles 34

c. Manned Bombers 35

2. General Limitations and Uncertainties 37

3. Measures Considered in this Section 38

ICBM LAUNCHERS 40

BALLISTIC MISSILE SUBMARINES 44

SLBM LAUNCHERS 48

ICBM AND SLBM LAUNCHERS 52

INTERCONTINENTAL BOMBERS 54

STRATEGIC NUCLEAR DELIVERY VEHICLES 56

B. INDEPENDENTLY TARGETABLE WARHEADS 59

1. General 59

a. Multiple Warhead Ballistic Missiles 59

TABLE OF CONTENTS (Continued)

b. Bomber Weapon Loadings 60

2. General Limitations and Uncertainties 61

3. Measures Considered in this Section 61

NUMBER OF MIRVED ICBMs 62

NUMBER OF MIRVED SLBMs 64

NUMBER OF MIRVED ICBMs AND SLBMs 66

INDEPENDENTLY TARGETABLE ICBM WARHEADS 68

INDEPENDENTLY TARGETABLE SLBM WARHEADS 70

INDEPENDENTLY TARGETABLE ICBM AND SLBM WARHEADS 72

INDEPENDENTLY TARGETABLE BOMBER WARHEADS 74

INDEPENDENTLY TARGETABLE ICBM, SLBM AND BOMBER WARHEADS 76

C. THROW-WEIGHT 81

1. General 81

2. General Limitations and Uncertainties 81

3. Measure Considered in this Section 81

ICBM THROW-WEIGHT 82

D. SLBM MAXIMUM RANGE 85

1. General 85

2. General Limitations and Uncertainties 85

3. Measure Considered in this Section 85

SLBM MAXIMUM RANGE 86

E. GROSS YIELD 89

1. General 89

2. General Limitations and Uncertainties 89

3. Measures Considered in this Section 90

ICBM GROSS YIELD 92

SLBM GROSS YIELD 94

ICBM AND SLBM GROSS YIELD 96

BOMBER GROSS YIELD 98

ICBM, SLBM, AND BOMBER YIELD 100

F. EQUIVALENT MEGATONS 103

1. General 103

2. General Limitations and Uncertainties 104

TABLE OF CONTENTS (Continued)

3. Measures Considered in this Section.......... 104

ICBM EQUIVALENT MEGATONS.......... 106

SLBM EQUIVALENT MEGATONS.......... 108

ICBM AND SLBM EQUIVALENT MEGATONS.......... 110

BOMBER EQUIVALENT MEGATONS.......... 112

ICBM, SLBM AND BOMBER EQUIVALENT MEGATONS.......... 114

G. LETHAL AREA POTENTIAL.......... 115

1. General.......... 115

2. General Limitations and Uncertainties.......... 115

3. Measures Considered in this Section.......... 115

ICBM LETHAL AREA POTENTIAL.......... 116

SLBM LETHAL AREA POTENTIAL.......... 118

ICBM AND SLBM LETHAL AREA POTENTIAL.......... 120

BOMBER LETHAL AREA POTENTIAL.......... 122

ICBM, SLBM AND BOMBER LETHAL AREA POTENTIAL.......... 124

H. WEAPON SYSTEM ACCURACY.......... 125

1. General.......... 125

2. General Limitations and Uncertainties.......... 125

3. Measures Considered in this Section.......... 125

ACCURACY COMPARISON (1/CEP) US AND USSR ICBM.......... 126

ACCURACY COMPARISON (1/CEP) US AND USSR SLBMS.......... 128

AVERAGE ACCURACY OF THE ICBM FORCE.......... 130

AVERAGE ACCURACY OF THE SLBM FORCE.......... 132

AVERAGE ACCURACY OF THE COMBINED ICBM AND SLBM FORCE.......... 134

AVERAGE ACCURACY OF THE TOTAL STRATEGIC FORCE.......... 136

I. HARD TARGET KILL CAPABILITY.......... 139

1. General.......... 139

2. General Limitations and Uncertainties.......... 140

3. Measures Considered in this Section.......... 141

ICBM HARD TARGET KILL CAPABILITY, 1,000 PSI.......... 142

ICBM HARD TARGET KILL CAPABILITY, 2,000 PSI.......... 144

ICBM HARD TARGET KILL CAPABILITY, 3,000 PSI.......... 146

SLBM HARD TARGET KILL CAPABILITY, 1,000 PSI.......... 148

TABLE OF CONTENTS (Continued)

ICBM AND SLBM HARD TARGET KILL CAPABILITY, 1,000 PSI........... 150

BOMBER HARD TARGET KILL CAPABILITY, 1,000 PSI.................. 152

ICBM, SLBM AND BOMBER HARD TARGET KILL CAPABILITY, 1,000 PSI... 154

J. COUNTER MILITARY POTENTIAL.................................. 155

1. General... 155

2. General Limitations and Uncertainties....................... 155

3. Measures Considered in this Section......................... 156

ICBM COUNTER MILITARY POTENTIAL................................ 158

SLBM COUNTER MILITARY POTENTIAL................................ 160

ICBM AND SLBM COUNTER MILITARY POTENTIAL....................... 162

BOMBER COUNTER MILITARY POTENTIAL.............................. 164

ICBM, SLBM, AND BOMBER COUNTER MILITARY POTENTIAL.............. 166

K. ICBM FIRST STRIKE.. 169

1. General... 169

2. General Limitations and Uncertainties....................... 170

3. Measures Considered in this Section......................... 170

SURVIVING ICBM LAUNCHERS AFTER A FIRST STRIKE BY EITHER THE US OR USSR.. 172

SURVIVING ICBM WARHEADS AFTER A FIRST STRIKE BY EITHER THE US OR USSR.. 176

RESIDUAL ICBM LAUNCHERS AFTER A FIRST STRIKE BY EITHER THE US OR USSR.. 178

RESIDUAL ICBM WARHEADS AFTER A FIRST STRIKE BY EITHER THE US OR USSR.. 180

AVERAGE ICBM SILO HARDNESS..................................... 182

AVERAGE WARHEAD YIELD IN FIRST STRIKE.......................... 184

AVERAGE ACCURACY OF WARHEADS USED IN FIRST STRIKE.............. 186

SENSITIVITY OF FIRST STRIKE ANALYSIS TO CIRCULAR ERROR POTENTIAL... 188

SENSITIVITY OF FIRST STRIKE ANALYSIS TO YIELD.................. 190

SENSITIVITY OF FIRST STRIKE ANALYSIS TO TARGET HARDNESS........ 192

L. RETALIATORY EQUIVALENT WEAPONS............................... 195

1. General... 195

2. General Limitations and Uncertainties....................... 196

3. Measures Considered in this Section......................... 196

TABLE OF CONTENTS (Continued)

4. ICBM Retaliatory Equivalent Weapons.............................. 197
RELIABLE ICBM RETALIATORY EQUIVALENT WEAPONS, CASE I............ 200
RELIABLE ICBM RETALIATORY EQUIVALENT WEAPONS, CASE II........... 202
RELIABLE ICBM RETALIATORY EQUIVALENT WEAPONS, CASE III.......... 204
5. SLBM Retaliatory Equivalent Weapons.............................. 207
RELIABLE SLBM RETALIATORY EQUIVALENT WEAPONS.................... 208
RELIABLE ICBM AND SLBM RETALIATORY EQUIVALENT WEAPONS........... 210
6. Bomber Retaliatory Equivalent Weapons............................ 211
RELIABLE BOMBER RETALIATORY EQUIVALENT WEAPONS.................. 212
RELIABLE ICBM, SLBM AND BOMBER RETALIATORY EQUIVALENT WEAPONS... 214

M. STRATEGIC DEFENSIVE SYSTEMS... 217
1. General... 217
a. Anti-Ballistic Missile Forces.................................. 217
b. Anti-Submarine Warfare Forces.................................. 218
c. Air Defense Forces... 218
2. General Limitations and Uncertainties............................ 220
3. Measures Considered in this Section.............................. 220
STRATEGIC AIR DEFENSE INTERCEPTOR AIRCRAFT...................... 222
STRATEGIC SURFACE-TO-AIR MISSILE LAUNCHERS...................... 224

APPENDIX A. WARHEAD YIELD-TO-WEIGHT CAPABILITY........................ A-1
1. General... A-1
2. Measure... A-1
a. What it Measures.. A-1
b. Limitations... A-3
c. Uncertainties... A-4
d. Comment... A-4

APPENDIX B. POPULATION AND MANUFACTURING VALUE ADDED.................. B-1
1. General... B-1
2. Potential Targets... B-1
a. Population as a Target.. B-1
b. Manufacturing Capability as a Target............................ B-4

TABLE OF CONTENTS (Continued)

APPENDIX C. TARGETING UNCERTAINTIES C-1

1. General C-1

2. Launcher Position Uncertainties C-2

    a. Land-Based Launchers C-2

    b. Sea-Based Launchers C-2

3. Target Position Uncertainties C-3

4. Missile Flight Profile Uncertainties C-4

    a. Gravitational C-4

    b. Other Factors C-5

APPENDIX D. STRATEGIC ARMS LIMITATIONS AGREEMENTS D-1

1. General D-1

2. The Treaties and Agreements D-1

    a. The ABM Treaty D-1

    b. The Interim Agreement and Protocol D-2

    c. The ABM Protocol D-3

    d. The Vladivostok Summit D-3

    e. The Limited Test Ban Treaty D-4

    f. Threshold Test Ban Treaty and Protocol D-4

    g. Underground PNE Ban Treaty and Protocol D-5

3. Force Limits and Actual Levels D-5

APPENDIX E. DERIVATION OF FORMULAS E-1

1. General E-1

2. Derivations E-1

    a. Equivalent Megatons E-1

    b. Single-Shot Probability of Kill E-2

    c. Counter Military Potential E-4

    d. Hard Target Kill Capability E-5

APPENDIX F. TACTICAL/THEATER NUCLEAR FORCES F-1

1. Introduction F-1

2. Types of Weapons F-2

    a. United States F-2

    b. Soviet Union F-2

    c. Strategic Forces F-2

TABLE OF CONTENTS (Continued)

3. Forces Considered in this Appendix.................................. F-2

SHORT RANGE MISSILE LAUNCHERS.. F-4

MEDIUM RANGE/INTERMEDIATE RANGE BALLISTIC MISSILE (MR/IRBM) LAUNCHERS.. F-7

NUCLEAR-CAPABLE AIRCRAFT EXCLUDING LONG RANGE STRATEGIC BOMBERS...... F-8

SEA-LAUNCHED CRUISE MISSILE LAUNCHERS................................. F-10

APPENDIX G. STRATEGIC WEAPONS SYSTEMS.................................. G-1

1. General.. G-1

2. Tables... G-1

APPENDIX H. GLOSSARY OF TERMS... H-1

APPENDIX I. BIBLIOGRAPHY.. I-1

LIST OF FIGURES

I-1	Example Graph	24
I-2	Trends in US and USSR Strategic Forces	26
I-3	Trends in US and USSR Strategic Weapons	28
I-4	Trends in US and USSR Strategic Force Attack Capability	30
II-1	ICBM Launchers	40
II-2	Ballistic Missile Submarines	44
II-3	SLBM Launchers	48
II-4	ICBM and SLBM Launchers	52
II-5	Intercontinental Bombers	54
II-6	Strategic Nuclear Delivery Vehicles	56
II-7	MIRVed ICBMs	62
II-8	MIRVed SLBMs	64
II-9	MIRVed ICBMs and SLBMs	66
II-10	Independently Targetable ICBM Warheads	68
II-11	Independently Targetable SLBM Warheads	70
II-12	Independently Targetable ICBM and SLBM Warheads	72
II-13	Independently Targetable Bomber Warheads	74
II-14	Air-Launched Cruise Missiles	76
II-15	Independently Targetable ICBM, SLBM, and Bomber Warheads	78
II-16	Independently Targetable US Warheads by Type	79
II-17	Independently Targetable USSR Warheads by Type	79
II-18	ICBM Throw-Weight	82
II-19	SLBM Maximum Range	86
II-20	ICBM Gross Yield	92
II-21	SLBM Gross Yield	94
II-22	ICBM and SLBM Gross Yield	96
II-23	Bomber Gross Yield	98
II-24	ICBM, SLBM and Bomber Gross Yield	100
II-25	ICBM Equivalent Megatons	106
II-26	SLBM Equivalent Megatons	108
II-27	ICBM and SLBM Equivalent Megatons	110
II-28	Bomber Equivalent Megatons	112

LIST OF FIGURES (Continued)

II-29 ICBM, SLBM, and Bomber Equivalent Megatons 114

II-30 ICBM Lethal Area Potential 116

II-31 SLBM Lethal Area Potential 118

II-32 ICBM and SLBM Lethal Area Potential 120

II-33 Bomber Lethal Area Potential 122

II-34 ICBM, SLBM, and Bomber Lethal Area Potential 124

II-35 Accuracy Comparison (1/CEP) US and USSR ICBMs 126

II-36 Accuracy Comparison (1/CEP) US and USSR SLBMs 128

II-37 Average Accuracy of the ICBM Force 130

II-38 Average Accuracy of the SLBM Force 132

II-39 Average Accuracy of the Combined ICBM and SLBM Force 134

II-40 Average Accuracy of the Total Strategic Force (ICBM, SLBM, & Bombers) 136

II-41 ICBM Hard Target Kill Capability, 1,000 PSI 142

II-42 ICBM Hard Target Kill Capability, 2,000 PSI 144

II-43 ICBM Hard Target Kill Capability, 3,000 PSI 146

II-44 SLBM Hard Target Kill Capability, 1,000 PSI 148

II-45 ICBM and SLBM Hard Target Kill Capability, 1,000 PSI 150

II-46 Bomber Hard Target Kill Capability, 1,000 PSI 152

II-47 ICBM, SLBM, and Bomber Hard Target Kill Capability, 1,000 PSI. 154

II-48 ICBM Counter Military Potential 158

II-49 SLBM Counter Military Potential 160

II-50 ICBM and SLBM Counter Military Potential 162

II-51 Bomber Counter Military Potential 164

II-52 ICBM, SLBM, and Bomber Counter Military Potential 166

II-53 Surviving ICBM Launchers After a First Strike by Either the US or USSR 172

II-54 Surviving ICBM Warheads After a First Strike by Either the US or USSR 176

II-55 Residual ICBM Launchers After a First Strike by Either the US or USSR 178

II-56 Residual ICBM Warheads After a First Strike by Either the US or USSR 180

II-57 Average ICBM Silo Hardness 182

LIST OF FIGURES (Continued)

II-58 Average Warhead Yield in First Strike........................ 184

II-59 Average Accuracy of Warheads Used in First Strike............ 186

II-60 Sensitivity of First Strike Analysis to Circular Error Probable.. 188

II-61 Sensitivity of First Strike Analysis to Yield................ 190

II-62 Sensitivity of First Strike Analysis to Target Hardness...... 192

II-63 Reliable ICBM Retaliatory Equivalent Weapons, Case I......... 200

II-64 Reliable ICBM Retaliatory Equivalent Weapons, Case II........ 202

II-65 Reliable ICBM Retaliatory Equivalent Weapons, Case III....... 204

II-66 Reliable SLBM Retaliatory Equivalent Weapons................. 208

II-67 Reliable ICBM and SLBM Retaliatory Equivalent Weapons........ 210

II-68 Reliable Bomber Retaliatory Equivalent Weapons............... 212

II-69 Reliable ICBM, SLBM, and Bomber Retaliatory Equivalent Weapons.. 214

II-70 Strategic Air Defense Interceptor Aircraft................... 222

II-71 Strategic Surface-to-Air Missile (SAM) Launchers............. 224

A-1 Strategic Missile Warheads Yield-to-Weight Comparison........ A-2

B-1 Percent of Population Versus Number of Urban Areas........... B-2

B-2 Area with Respect to Number of Cities........................ B-3

B-3 Distribution of Population with Respect to Area..... .... B-3

B-4 Percent of Manufacturing Value Added with Respect to Urban Areas.. ...... B-5

C-1 Relationship of Launch Site, Target Position and Global Reference System.. C-2

C-2 Effects of Gravity on Missile Trajectory..................... C-4

E-1 Blast Volume... E-1

F-1 Short Range Missile Launchers......................... ...... F-4

F-2 Number of Short Range Surface-to-Surface Missile Launchers, 1977 Inventory.. F-5

F-3 Range Capability of Surface-to-Surface Short Range Missiles, 1977 Inventory..................................... F-6

F-4 Nuclear Capable Aircraft Excluding Long Range Strategic Bombers.. F-8

F-5 Sea-Launched Cruise Missile Launchers....................... F-10

LIST OF TABLES

II-1	ABM Launchers	218
D-1	SALT I Force Limitations· Levels Frozen as of May 1972	D-6
D-2	Vladivostok Guidelines and 1978 Force Levels	D-7
F-1	USSR MR/IRBM 1977 Inventory	F-7
G-1	US ICBM Characteristics	G-2
G-2	MINUTEMAN Silo Hardness Upgrading Schedule	G-3
G-3	MK12A Phase-In Schedule	G-3
G-4	USSR ICBM Characteristics	G-4
G-5	US SLBM Characteristics	G-5
G-6	USSR SLBM Characteristics	G-5
G-7	US and USSR Bomber Weapons Characteristics	G-6

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I. SUMMARY (U)

A. INTRODUCTION (U)

1. (U) General. This report is a compilation and description of the measures of effectiveness which have been used in the analysis and comparison of US and USSR strategic nuclear forces and weapons systems. The primary purpose of the report is to provide an understanding of the measures of effectiveness which can be used in an analysis of the strategic balance. Although a knowledgeable strategic analyst may consider some of the discussions elementary, the manner of presentation has been selected to make the report useful to a wide range of readers.

Historical trend plots of thirteen general measures of effectiveness and relevant subsets of these measures of effectiveness are presented. For each measure, a description which identifies the limitations and uncertainties associated with the particular measure is provided:

The thirteen basic measures considered are:

- Strategic Nuclear Delivery Vehicles;
- Independently Targetable Warheads,
- ICBM Throw-Weight;
- SLBM Maximum Range;
- Gross Yield;
- Equivalent Megatons;
- Lethal Area Potential;
- Weapon System Delivery Accuracy;
- Hard Target Kill Capability;
- Counter Military Potential;
- Surviving ICBM Launchers;
- Retaliatory Equivalent Weapons;
- Strategic Defensive Systems.

A conscious effort was made to provide an unbiased trend analysis for each measure through the use of valid source materials and comparable data. Each of the trend graphs is thus a visual comparison of some aspect of the strategic balance.

2. Background. From July 1945 until August of 1949 the United States had a nuclear monopoly. Since August 1949, when the Soviet Union exploded its first nuclear device, analysts have been confronted with the problem of portraying the strategic nuclear balance in a meaningful manner. (U)

(U) The first nuclear delivery vehicle was the manned bomber. Because of the weight of early nuclear weapons (over five tons), bombers of the late 1940s and early 1950s could only carry a single weapon. In 1949, the US nuclear-capable aircraft were piston-powered B-29s, B-50s, and B-36s. Of these aircraft, only the B-36 had the capability to fly a 10,000 mile (intercontinental) mission with a nuclear weapon. At the same time, the only Soviet nuclear-capable delivery vehicle was the TU-4 BULL, which was a direct copy of the US B-29.

(U) Subsequently, the capability to deliver nuclear weapons with missiles was developed. The Intermediate Range Ballistic Missile (IRBM) which could be deployed to countries within range of potential targets was introduced in 1958. The ballistic missile with intercontinental range (ICBM) was introduced in 1959. Missile payload, reliability, and accuracy were some of the new factors that had to be considered in addition to prelaunch survivability as a result of these changes.

(U) The strategic nuclear balance analysis problem became even more complex with the addition of the Submarine-Launched Ballistic Missile (SLBM) to the Soviet nuclear arsenal in 1958 and the US arsenal in 196[illegible]. The additional factors that had to be considered included alert rates and missile range.

(U) Further technological advances have led to multiple reentry vehicles, hardened silos, stand-off weapons, Anti-Ballistic Missile (ABM) systems, etc. Each of these has, in turn, introduced its own set of complexities to the problem of deriving a meaningful measure or set of measures of effectiveness.

B. (U) MEASURES OF EFFECTIVENESS.

1. General. Measures of effectiveness used in the analysis and comparison of nuclear forces fall into one of two general categories, static and dynamic.

Static measures of effectiveness are concerned with one or more particular aspects of nuclear forces. At first, such measures concentrated on a single weapon or force attribute (e.g., number of strategic nuclear delivery vehicles, number of independently targetable warheads, total yield, etc.). More recent static measures have combined more than one weapon system and/or target attribute into a single measure (e.g., counter military potential, hard target kill capability, etc.). Such measures, called aggregate measures, were developed in an attempt to account for some of the biases present in a measure because of its single attribute. For example, yield is a single attribute measure. However, yield taken by itself does not consider any other weapon or target characteristic. In order to consider the usefulness of a weapon several other factors should be considered. One of these factors is accuracy, a measure of how close to a target a weapon can be expected to be placed. The measure of accuracy is CEP (Circular Error Probable). The two single attribute measures, yield and accuracy, have been combined into an aggregate measure called counter military potential (CMP). This measure, CMP, is easy to calculate; however, it has the disadvantage of disregarding the target set. The prime disadvantage of static measures is that they tend to disregard some relevant factor.

Dynamic measures of effectiveness are those which seek to determine relative force effectiveness by estimating the probable outcome of a hypothetical nuclear attack or exchange conducted against various target sets. Such measures provide a probabilistic solution to the potential effectiveness of a force in various scenarios. The advantage of a dynamic measure is that it may provide the answer to "what if" questions. However, such measures are not without disadvantages which include reliance upon the assumptions used in developing the scenario and uncertainties present in the modeling process. These more sophisticated dynamic measures range from single point expected outcome analysis through large complex models which

attempt to account for a multitude of factors. The problem in many cases is that a great deal of uncertainty exists about the factors which influence the model results.

In short, there is no single measure of effectiveness available which can answer all of the questions which may need to be addressed in an assessment of the strategic balance. There are, however, measures which are useful in addressing some particular aspect of this balance. This report attempts to present the generally used measures in a meaningful manner, in an unbiased form, in order to permit further assessment.

2. Traditional Indices. Traditionally, about five or six measures have been utilized to compare the US/Soviet strategic balance. This paper is intended to describe those indices which have been utilized and explain their limitations and the uncertainties associated with their derivation.

These measures and a brief description are:

- Strategic Nuclear Delivery Vehicles--the number of missiles and bombers with a strategic nuclear delivery capability. This unit is the basis of arms-control agreements. It also forms the starting point for all other measurements and calculations.

- Total yield--the sum of the individual yield in megatons of each of the deliverable warheads (bombs and missiles).

- Warheads--the total number of individually targetable missile reentry vehicles and bombs in the inventory.

- Payload--the total weight of the weapons carried.

- Throw-weight--a measure of a missile's load carrying capability. It is used to measure the total weight of the objects (warheads, decoys, dispensers, bus, etc.) which may be carried by the booster. Here booster is meant to include the boost stages and fuel used in those stages of the missile.

The above measures were obtained by counting or summing the various units. There was little or no comparison of effectiveness of the various items. Some additional measures attempted to compare system effectiveness. Two of these are:

- Accuracy--the accuracy of a given nuclear delivery system will provide some measure of the effectiveness of the system. However, a comparison of accuracy capability by itself with-

out considering target hardness or weapon yield has limited usefulness. In addition, accuracy varies greatly with the various systems in the inventory and normally only the newest systems will attain the improved accuracy.

- Range--a comparison of range capability will provide some measure of targeting capability. Today, however, US and USSR ICBM's have a range capability which allows targeting any point in the other country. Range capability does play an important part in the planning and deployment of ballistic missile submarines. All potential targets are not susceptible to attack from all such submarines at all times. In addition, the shorter the range of its missiles, the smaller the available operating area is for the submarine.

Any measure of offensive forces can be misleading without consideration of the opponent's defensive capabilities. One should address air defenses, Anti-Submarine Warfare (ASW), and Anti-Ballistic Missile (ABM) assets.

- Strategic surface-to-air missile systems--the total number of surface-to-air launchers.

- Strategic air defense interceptor aircraft--the total number of aircraft assigned a strategic interceptor role.

The ASW forces and capabilities of either side were not addressed in this document. The ABM treaty eliminates the necessity of a detailed comparison of the ABM systems of the US and USSR.

3. Other Indices. None of the above measures or indices provide any comparison of the damage capability of the forces. Therefore, other indices have been developed which attempt to measure the strategic nuclear balance. These indices approach the analysis problem from the point of view of the effect on the target (i.e., targets killed or target damage), and attempt to equate the variety of nuclear weapon systems to simple meaningful terms.

- Lethal Area Potential--blast overpressure is one of the destructive mechanisms of nuclear explosions. This measure is an estimation of the total area which can be covered with some overpressure--usually 15 psi. The problem is that targets are not homogeneously distributed. They vary in area and spacing.

- Equivalent Megatons (EMT)--recognizes the fact that a weapon with a 20 Megaton (MT) yield does not produce twenty times the damage of a 1 MT weapon. Analysis shows that the area subjected to a given blast overpressure is proportional to the two-thirds power of the weapon's yield. In terms of a soft urban-industrial area target, if the target area is large enough, a 20 MT weapon will destroy only a little more than seven times that of a 1 MT weapon. The sum of the individual weapon's EMT of a force was defined as the force EMT and was an indication of the total soft target area which could be covered by an ideal barrage.

Since EMT only measures damage to soft area targets (e.g., cities) and is not meaningful for a comparison against hardened point targets, another index has been derived.

- Counter Military Potential (CMP)--obtained by dividing the equivalent yield by the square of the accuracy or aiming error (CEP^2). It is also called lethality. This measure still does not directly consider target hardness; however, inclusion of accuracy in the measure does provide some consideration that target destruction is in part determined by the effect at the target.

None of the above indices considers the characteristics of the target. Since targets vary greatly in terms of their vulnerability to nuclear weapon effects, a measure of strategic balance which includes target response should be considered.

The analyst has many factors which may be used, all of which will affect the comparison in varying degrees. He must consider addressing weapon characteristics (i.e., number, yield, CEP, reliability, capability to penetrate a defensive system, etc.), target characteristics (i.e., number, type, response to nuclear weapon effects, defensive systems, etc.), targeting philosophy, target priorities, and attack objectives. To compare strategic forces' capabilities, one then addresses the probability of damaging a target system to a desired level with the weapons available. The simplest of this type of measure totals and compares the numbers of a given type of target each side can damage, assuming an all-out strike.

- Hard Target Kill Capability--a comparison of the ability of either force to destroy hardened targets. The composition and characteristics of each force are used against a given target set. The number of hardened targets which can be killed is compared.

- Surviving ICBM Launchers--another example which can be utilized to portray the strategic balance is one in which the analyst calculates a first strike by one side against the other's offensive weapons. After calculating the effectiveness of the strike, he reverses the roles and recalculates. A comparison of the results of the two situations will provide an indication of both the first-strike kill capability and the number of weapons remaining for additional strikes. It will also provide an indication of the retaliatory forces available to the side suffering the initial attack. This measure, if done using appropriate target and weapon system characteristics, can provide meaningful results.

An extension of the above uses the weapons surviving a first-strike and determines the capability of these weapons in a retaliatory role.

- Retaliatory Equivalent Weapons--a measure of the effectiveness of a force against a generalized target structure after suffering a first strike. Considered in this measure are available (surviving) weapons and their characteristics against a designated target structure with its characteristics.[1]

4. Limitations and Uncertainties. Our perception of Soviet weapon systems and targets in the Soviet Union are derived from intelligence sources. As a result, estimates of characteristics and quantities are by necessity, imperfect. In order to account for such imperfections, intelligence sources often provide a range for various factors. One common method of threat assessment is to produce "high", "low" and "best" estimates. Where data sources have used this method, the "best" estimate has been selected for this report. Where weapon or target characteristics were provided as a range of values, the mid point has been used in this report.

The effects of nuclear weapons on various target structures have been studied in great detail. However, treaties between the US and USSR concerning nuclear explosions prohibit certain types of tests and limit others.[2]

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[1] Fred A. Payne, "The Strategic Nuclear Balance: A New Measure," Survival, Volume XX, Number 3, May/June 1977, pp. 107-110.

[2] Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space, and Under Water, October 10, 1963; Treaty Between the United States of America and the Union of Soviet Socialist Republics and Protocol to the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitations of Underground Nuclear Weapon Tests, July 3,

Underground nuclear tests, which are difficult and costly, are the only types of tests allowed by the treaties. Because they are conducted underground, nuclear weapon effects tests must simulate the environment to which an object is being tested. These factors make it difficult to collect and evaluate data with respect to the above-ground condition of a nuclear attack. As a result, there is a range of uncertainty associated with both the actual effects that may result from a nuclear explosion and the hardness of targets to weapon effects. Weapon yield, height of burst, atmospheric conditions, terrain, soil, and accuracy are some of the factors that must be accounted for in nuclear weapon damage assessment. Each of these factors is subject to variation or error. The values used in analytic solutions have been selected based upon normal distributions which in many cases are derived from small sample sets. Target hardness, in a similar manner, has a range of values. For example, a set of silos constructed to the same specifications in addition to range of uncertainty associated with the expected hardness due to the construction, will also have varying hardnesses because of soil conditions, terrain effects, etc.

Another uncertainty associated with the targets is position. These include uncertainties introduced by techniques employed to derive target positions and the accuracy of surveys.

Two other factors should be considered in damage assessment. These are fratricide and the synergistic effects of multiple weapon attacks. Fratricide results from the nuclear effects caused by a weapon explosion, and it includes turbulence, EMP, dust lofting, radiation, etc. The end result may be the destruction or damage to another nuclear warhead. The second weapon may also be deflected from its intended path or caused to detonate early or late as a result of the first nuclear explosion. The usual treatment of multiple weapon attacks disregards any weakening or damage that may occur to the target structure as a result of the first nuclear explosion. Hence, the synergistic effects of multiple weapon attacks have been disregarded except to estimate that the timing problem may be solved when a multiple weapon attack is limited to two weapons per target.

1974 (also known as the Threshold Test Ban Treaty); Treaty Between the United States of America and the Union of Soviet Socialist Republics and Protocol to the Treaty on Underground Nuclear Explosions for Peaceful Purposes, May 28, 1976.

Failure to systematically treat the variables in dynamic assessment is often caused by a lack of knowledge about weapon effects and constraints on efficient force use. In addition, the analytic model itself may contain uncertainties or inaccuracies because of gaps or a lack of knowledge about the physical process being modeled.

The accuracy of a measure of effectiveness is limited by the uncertainties and inaccuracies present in the data which are used to develop the measure. In the main body of the text the uncertainties and inaccuracies which may be present in the source data are described in order to provide the reader with an insight into the accuracy and limitations present in the comparison.

C. (U) METHOD OF PRESENTATION.

This report, as previously stated, is a compilation of the measures of effectiveness which have been used to compare US and USSR nuclear forces and nuclear force capabilities. A standard graphic technique has been used to portray the comparison, whenever possible. This method permits a visual comparison of trends and projections in the various measures of effectiveness.

The graphic technique, which is illustrated by Figure 1-1 (Example Graph), depicts the comparative value of both the United States' and Soviet Union's forces at various past, present, and projected points in time. The US value is shown vertically along the ordinate and the Soviet value horizontally along the abscissa. A diagonal line on the graph is provided as an aid for visually determining the trend. A point which is above or to the left of the diagonal indicates that the United States has the advantage for this particular point in time for this measure of effectiveness. Correspondingly, a point below or to the right of the diagonal reference line indicates that the advantage belongs to the Soviet Union. Points which fall on the diagonal indicate equality with neither the US nor USSR having an advantage. Thus, the method of presentation provides a trend line, a comparison of both forces, and the absolute value for both forces on a single graph.

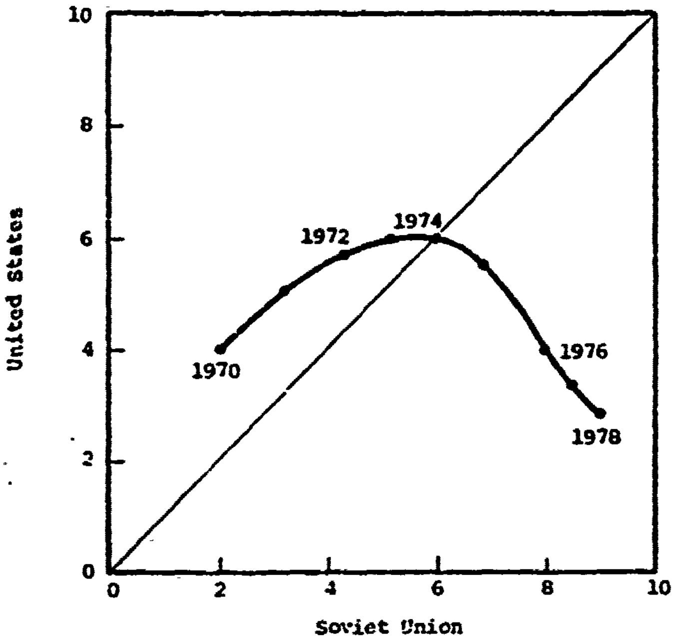

Figure I-1. Example Graph

In Figure I-1, the United States had a 2-to-1 (i.e., 4-to-2 on the graph) advantage in 1970. By 1974, although both nations had increased their force levels, the Soviet Union had achieved equality with the United States (the value for each nation is 6 and consequently is plotted on the diagonal). Starting in 1974, the United States' absolute value shows a steady decline (as would be the case were forces reduced, warhead yields decreased, etc.) while the Soviet Union continues to add to value.

By 1976, the Soviet Union has achieved a 2-to-1 (i.e., 8-to-4 on the graph) advantage. Additionally the projected trend indicates a further advantage to the Soviet Union of 3-to-1 (i.e., 9-to-3 on the graph) by 1978.

D. GENERAL OBSERVATIONS. (U)

(U) A summary of the thirteen basic measures and many of their relevant subsets is provided in Figures I-2 through I-4 which follow. Also shown is the ratio of advantage in 1986. When considering ratios care must be exercised. For example, an advantage of 1.3 to 1 in strategic nuclear delivery vehicles would not be very significant when one side has 1,300 and the other has 1,000. On the other hand a 1.3 to 1 advantage might be significant where one side has the capability of destroying 10,000 targets and the other side has the capability of destroying 13,000 targets.

(U) Figures I-2 through I-4 divide the measures into three general categories. These are forces in Figure I-2, weapon related measures in Figure I-3, and attack capability in Figure I-4.

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Figure I-2 (Trends in US and USSR Strategic Forces) indicates the relative advantage for those measures which are based on numbers of weapons systems. In 1986 the Soviet Union will have a clear advantage in total strategic nuclear delivery vehicles and defensive systems. The United States will have an advantage in total independently targetable warheads. (U)

- (U) Total Strategic Nuclear Delivery Vehicles--The USSR gained the advantage in 1972 mainly as the result of their build up in numbers of ICBM launchers, which exceeded the US total in 1969 and the increased numbers of Soviet SLBM launchers which exceeded the number of US SLBM launchers in 1973.

- (U) Total MIRVed Missiles--the United States' current advantage in total MIRVed missiles will be eroded during the period with the Soviets gaining the advantage by 1984 mainly as a result of increases in the number of MIRVed Soviet ICBM launchers.

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Figure I-3 (Trends in US and USSR Strategic Force Weapon Related Measures) illustrates the advantage for six basic measures. In 1986, the Soviet Union will have a clear advantage in four of these, the United States will lead in one, and in one measure neither side has a clear advantage. (U)

- (U) ICBM Throw-weight--The Soviet Union gained the advantage in total ICBM throw-weight in 1967. This was primarily due to the US decision to deploy relatively small, solid propulsion ICBMs and the Soviet continuation of the development and deployment of larger, liquid propulsion ICBMs. They will continue to increase their advantage in this measure and by 1986 will have a 3.8 to 1 advantage over the United States.

- (U) SLBM Maximum Range--Introduction of the 4000 nautical mile range TRIDENT C-4 missile into the US SSBN force on the POSEIDON missile submarines in 1980 will approximately match the Soviet maximum range of 4200 for the SSN-8 missile. No other changes in this measure are expected during the period of time considered in the analysis.

- (U) Total Force Accuracy--The United States has an advantage in average force accuracy for the entire period considered. A major contribution to this advantage is the result of the weighted average accuracy of the bomber force which has not been separately illustrated in Figure I-3. The contribution of US ALCM to total force average accuracy will become more significant as this weapon is phased in in large numbers in the 1980s.

- (U) Total Equivalent Megatons--Total equivalent megatons, like total gross yield is the summation of the three delivery elements. The Soviet advantage of 2.1 to 1 in 1986 for this measure is also attributed to the Soviet advantage in ICBMs.

- (U) Total Lethal Area Potential--Total lethal area potential in a similar manner is also a summation of the three delivery element contributions. The Soviet overall advantage is mainly due to the greater number of warheads and higher yields in their ICBM force.

Pages 30 and 31 were Deleted.

E. (U) REPORT ORGANIZATION. Chapter II of this report consists of thirteen sections. Each of these sections contains a description and discussion of one of the basic measures of effectiveness and its relevant subsets. The sections have been arranged so that each section is a logical extension of the preceding material. Taken in sequence they cover numbers of strategic nuclear delivery vehicles, numbers of independently targetable warheads, strategic nuclear weapons characteristics, and then nuclear weapon capabilities. The next two sections address ICBM first strikes and retaliation. The last section is devoted to defensive systems.

Nine appendices are provided which contain amplifying and reference materials. These are:

- Appendix A -- Strategic ballistic missile warhead yield-to-weight relationships.
- Appendix B -- A summary of some considerations concerning countervalue target structures.
- Appendix C -- A brief description of targeting uncertainties.
- Appendix D -- Highlights of US/USSR strategic arms limitation agreements.
- Appendix E -- Discussion of derivation of formulas used in the analysis.
- Appendix F -- Brief description of tactical/theater nuclear forces and some of the difficulties associated with direct comparisons of these forces.
- Appendix G -- Tabular listings of strategic nuclear weapon characteristics.
- Appendix H -- Glossary of terms.
- Appendix I -- Bibliography.

II. THE MEASURES AND TRENDS (U)

A. STRATEGIC NUCLEAR DELIVERY VEHICLES. (U)

1. General. This section addresses the strategic balance in terms of strategic nuclear delivery vehicles. Weapon systems that have a primary role other than strategic warfare (i.e., non-central) are not included, except as noted in the discussion of individual measures. (U)

(U) A common method of determining a nation's force levels in ICBMs and SLBMs is to count the missile launchers. Although a nation may have more missiles than launchers, the number of launchers is the limiting factor in numerical terms of a first strike. The size of the missiles and the damage done to the launcher during firing generally preclude the rapid reloading of modern systems. Even a "cold launch" system, wherein the missile is ejected from the silo prior to booster ignition (as is attributed by some analysts to the Soviet SS-17s and SS-18s), requires an appreciable amount of time to reload. Submarines would have to return to port or at least rendezvous with a tender in a protected anchorage in order to reload.

(U) Bombers, on the other hand, can and often do, carry more than a single nuclear weapon. In fact, they often carry a mix of weapons for a single mission. For example, in one operational configuration the B-52G/H can carry 4 gravity bombs and 20 Short Range Attack Missiles (SRAMs).

a. (U) Intercontinental Ballistic Missiles. Early improvements in nuclear weapon technology led to the development of lighter and smaller nuclear devices. By coupling these improvements with ballistic missile technology, both the United States and the Soviet Union were able to deploy ballistic missiles as a means of delivering nuclear weapons. Both nations have had several different missile systems in their inventories over the years. While there are Medium Range Ballistic Missiles (MRBMs) and Inter-

mediate Range Ballistic Missiles (IRBMs)[3] in the Soviet inventory, these weapons systems have not been included in this force comparison since they are designed, intended, and deployed for tactical or theater use. The United States at present has no IRBMs or MRBMs.

History's first ICBM launch is believed to have occurred on August 3, 1957, when the Soviets launched an SS-6 ICBM which traveled several thousand miles before impacting in Soviet Siberia. The Soviet news agency Tass announced that a "super-long distance, intercontinental multi-stage ballistic rocket flew at an...unprecedented altitude...and landed in the target area." The first US ICBMs, assigned to the US Air Force, became operational almost two years later, in 1959. The six initial US ATLAS-D missiles were the forerunners of today's US ICBM force of 54 TITAN II, 450 MINUTEMAN II, and 550 MINUTEMAN III missiles.

b. Submarine-Launched Ballistic Missiles. During the 1950s, both the US and USSR began major efforts to provide their navies with an SLBM capability. The first experimental launch of a ballistic missile from a submarine was a Soviet launch which occurred in September 1955. This preceded the first submarine launchings of US POLARIS SLBM test missiles by almost 4-1/2 years. (U)

(U) The first Soviet submarines equipped to carry SLBMs were conventionally powered (diesel) types which were converted to missile launching platforms during the period 1955-57. They were equipped with two tubes for the surface launch of the SSN-4 SARK missile, which was a nuclear-capable weapon with a range of about 3?0 nautical miles. Between 1958 and 1962, the Soviet Navy added 23 GOLF diesel submarines and eight HOTEL nuclear submarines to their forces.[4] These submarines could initially fire three of the SSN-4 SARK missiles. Subsequently, the eight HOTEL and about half of the GOLFs were modified to carry the longer-range, underwater-launch SSN-5 SERB missile.

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[3] Department of Defense Dictionary of Military and Associated Terms defines ICBM ranges as 3,000 to 8,000 nautical miles; IRBM ranges as 1,500 to 3,000 nautical miles; and MRBM ranges as 600 to 1,500 nautical miles.

[4] Post-World War II Soviet submarine classes are assigned letter code designations by US-NATO intelligence, with the phonetic names GOLF and HOTEL being used for the letter "G" and "H" designations, respectively. One GOLF-class submarine was lost at sea in 1967.

(U) The nuclear-propelled USS GEORGE WASHINGTON, the first US ballistic missile submarine (SSBN), went to sea on its first "deterrent patrol" on November 15, 1960. The GEORGE WASHINGTON carried 16 POLARIS A-1 missiles which were designed for underwater launches. The POLARIS A-1 was armed with a nuclear warhead and had a range of 1,200 nautical miles. Forty additional 16-tube, nuclear-propelled submarines were completed by the US Navy through 1967. Their missiles were successively updated through the POLARIS A-2, POLARIS A-3, and POSEIDON C-3 missiles. Today, 10 older submarines have the 2,500 mile A-3 missile with Multiple Reentry Vehicles (MRV), while 31 have been refitted with Poseidon missiles, each carrying a nominal load of 10 Multiple Independently targeted Reentry Vehicles (MIRVs).

c. Manned Bombers. The manned bomber became the first nuclear delivery vehicle in August 1945 when the B-29 SUPERFORTRESS bombers of the US Army Air Force released atomic bombs over Nagasaki and Hiroshima, Japan. From then until the mid-1950s, the bomber was the only nuclear-capable weapon system available to either nation. In 1948, with the introduction of the B-36 bomber, the US Strategic Air Command (SAC) had a nuclear delivery vehicle which could reach targets in the Soviet Union from US bases without refueling. (U)

(U) The first jet-propelled B-47 STRATOJET bombers were delivered to SAC in 1951. The B-47, carrying two nuclear weapons, could achieve speeds up to 600 m.p.h., but lacked the range to reach targets in the Soviet Union from bases in the United States. As a result, large numbers of KC-97 tanker aircraft were procured to provide the B-47s with in-flight refueling, and SAC bases were established in Great Britain, Spain, and Morocco.

(U) The US Navy began its contribution to the nation's nuclear strike capability in 1951. The new AJ SAVAGE piston-engine[5] aircraft began periodic flights from the large MIDWAY-class aircraft carriers operating in the Mediterranean Sea. This was the first US Navy nuclear-capable, carrier-based aircraft. Soon thereafter the smaller ESSEX-class carriers were fitted to handle nuclear weapons, with the AJ SAVAGE. Later, A SKYWARRIER (jet) attack aircraft were added to the standard carrier air groups. With the addition to the US fleet of the POLARIS submarine the attack aircraft carriers were relieved of their strategic nuclear strike role by 1962. Aircraft carriers still have a nuclear strike capability, but they are not assigned a strategic role. No naval air forces have been included in any of the strategic measures in this report.

(U) The present US strategic bomber force is composed of the large, eight-jet B-52 STRATOFORTRESS, which was first delivered to SAC in 1955, and the smaller FB-111 aircraft first delivered in 1969. The B-52 has a comparatively large weapons payload which is carried internally and on wing pylons, and the aircraft has intercontinental range. A force of KC-135 tanker aircraft is maintained to provide an air-to-air refueling capability and thereby increases the range of the bomber force.

(U) Early in the nuclear arms race the Soviets appeared to be following the United States with the emphasis on strategic bombers. In fact, their strategic bomber, the TU-4 BULL, was a direct copy of the B-29.[6] In the mid-1950s, Soviet Long-Range Aviation (LRA) began receiving the TU-16 BADGER, a swept-wing jet bomber comparable in size, role, and performance to the US B-47. A manifestation of the Soviet tendency to "build big," the BADGER has only two engines, each developing an estimated 18,180 pounds of thrust, as compared to 7,200 pounds of thrust for each of the six engines in the B-47E.

[5] The AJ had two piston engines and a turbojet booster.

[6] Names of Soviet aircraft used herein (e.g., BULL) are of NATO origin.

(U) The world's only turbo-prop strategic bomber, the TU-95 BEAR, appeared a short time later, in 1955.[7] Soviet LRA began receiving the BEAR and the four-jet MYA-4 BISON bombers in 1956.

2. (U) General Limitations and Uncertainties. The measures in this section address only the numbers of strategic nuclear delivery vehicles. They disregard individual delivery vehicle and weapon characteristics. Operational considerations such as reliability, alert rate, mission, etc., are also ignored. As a result, such comparisons, although valid, provide a very limited picture of the strategic balance.

Current and past numbers of delivery vehicles are known with reasonable accuracy. However, future projections are intelligence estimates which are based upon the assumption that a Strategic Arms Limitation (SAL) agreement will be reached. Additionally, there is disagreement between the United States and Soviet Union concerning exactly what should be counted in force levels. For example, it would be advantageous to the United States if the Soviet BACKFIRE bomber were included in any limitation of strategic nuclear delivery vehicles. However, the Soviet Union has taken the position that this is a medium bomber intended for peripheral missions.

[7] (U) The Soviet military designation for this aircraft is TU-20. US publications generally identify the BEAR as the TU-95, which is the Tupelov design bureau designation.

3. <u>Measures Considered in This Section:</u>

Intercontinental Ballistic Missile Launchers
Ballistic Missile Submarines
Submarine-Launched Ballistic Missile Launchers
Intercontinental Ballistic Missile Launchers and Submarine-Launched Missile Launchers
Intercontinental Bombers
Strategic Nuclear Delivery Vehicles (U)

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ICBM LAUNCHERS (U)

(U) Although the ICBM is the actual delivery vehicle, counting launchers produces a more comparable measure. It is recognized that a nation usually has more ICBMs available than launchers; however, the amount of time required to recondition and/or reload a launcher is such that by counting only the launch positions a valid measure of first strike capability is derived. Additionally, since ICBMs may be concealed with less difficulty than silos or launch pads, using launching positions as the measure provides a comparable set of data for both the United States and the Soviet Union.

Limitations. At any point in time some ICBM launchers are not operational but are being upgraded, replaced, etc. In addition, those ICBM launching positions which have missiles in place are not all necessarily operationally ready as the missiles and their launch and control facilities require periodic maintenance and repairs. As a result, this measure tends to overestimate the number of missiles available for a first launch (U)

(U) By counting only those missiles with an intercontinental range, the measure does not include two other categories of land-based missile systems. These are: Intermediate Range Ballistic Missiles (IRBMs) and/or mobile systems which by advanced basing would have the capability of reaching another nation's homeland.

(U) Uncertainties. There is little uncertainty associated with current and past numbers of Soviet ICBM launchers. Future projections, however, are intelligence estimates which are based upon the assumption that a Strategic Arms Limitation (SAL) agreement will be achieved.

(U) Comment. The projections for future years are intelligence estimates which are based upon an assumption that a SAL agreement will be reached between the United States and Soviet Union which places a limit upon number and types of weapons each nation could deploy. This assumption concurs with the informal agreement reached at Vladivostok in November 1974. The projections indicate that the Soviet Union will deploy newer land-based systems at a slower rate than that at which older ICBM systems are decom-

missioned while the United States retains its existing ICBM force. The projections also consider that the Soviet Union will deploy additional Submarine-Launched Ballistic Missiles (SLBMs) within the latitude provided by retirement of ICBMs. As a result, while this measure projects a decrease in the number of Soviet ICBM launchers, the measure of SLBM launchers projects a roughly equivalent increase.

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BALLISTIC MISSILE SUBMARINES (U)

<u>What it Measures</u>. This measure is a count of the number of ballistic missile submarines, regardless of status. (U)

(U) During the early years (1960 to 1967) the Soviet ballistic missile submarine force was primarily composed of diesel-powered GOLF-class submarines (SSBs). From 1967 to 1977, these SSBs became less important as the YANKEE-class and DELTA-class nuclear-powered ballistic missile submarines (SSBNs) were deployed.

(U) In Figure II-2, the solid line includes only the SSBNs, while the dashed line includes both SSBNs and SSBs.

(U) <u>Limitations</u>. This measure, by simply totaling SSBNs and SSBs, treats all such submarines the same and thereby disregards the individual submarine capabilities. The older, less capable diesel submarine is counted the same as the newer, more capable nuclear submarine. Factors such as numbers of launching tubes, missile characteristics, etc., are also not considered by this measure.

The vulnerability of a ballistic missile submarine to detection and attack is in part related to missile range. In this regard the operating area available to a submarine when on station is a function of missile range. The larger this area the less vulnerable the submarine is to Anti-Submarine Warfare (ASW) action. This vulnerability is not considered in this measure nor are such other factors as submarine acoustic signature, speed, operating depth, etc.

(U) <u>Uncertainties</u>. Current and past numbers of Soviet ballistic missile submarines are well known. There is some uncertainty about future estimates which are based upon the assumption of a SAL agreement. These future numbers could vary depending upon Soviet options and decisions to place more or less reliance on SLBMs.

(U) A SAL agreement could change either the rate at which new submarines are deployed or the rate at which older submarines are decommissioned or both.

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SLBM LAUNCHERS (U)

<u>What it Measures</u>. This measure is a count of Submarine-Launched Ballistic Missile (SLBM) launchers. The total number of SLBM launchers is determined by counting ballistic missile submarines by type, multiplying by the number of SLBM launching tubes in each type, and totaling across the force. In 1968, for example, the US had 41 POLARIS submarines with 16 launching tubes each. Therefore, in 1968 the US had 656 SLBM launchers (U)

(U) For the early years (1960 to 1977) the measure includes the SLBM launchers in Soviet diesel-powered GOLF class submarines (SSBs). After 1978, only the Soviet nuclear-powered ballistic missile submarines (SSBNs) and their launchers are included. This agrees with an assumption that a future SAL agreement will not include the GOLF class SSBs in the Soviet total of strategic nuclear delivery vehicles.

(U) The 1972 interim SAL agreement permitted the US to increase to a ceiling of 710 SLBM launchers and 44 submarines from the present 656 launchers on 41 submarines only by replacing 54 older ICBM launchers. For this report it was assumed that the US SLBM launchers would remain at approximately 656 and therefore TRIDENT submarines would replace the older POLARIS submarines on a tube-for-tube basis. This would require decommissioning three 16-tube POLARIS submarines for every two 24-tube TRIDENT submarines added to the force.

(U) Limitations. Counting the number of launching tubes in ballistic missile submarines does not take into consideration individual system effectiveness. For example, with this measure a launching tube in a Soviet DELTA-class SSBN and a launching tube in a Soviet GOLF-class SSB are considered equal. This has the result of treating a longer-range SSN-8 SLBM the same as a much shorter-range SSN-4 or SSN-5 missile. Factors such as pre-launch survivability, hardness to nuclear effects, alert rate, MIRV capability, reliability, yield, accuracy, etc., are also not considered.

This measure does not consider the type of submarine which has the SLBM tubes. For example, each tube in a nuclear-powered submarine is treated in the same manner as one in a conventionally-powered submarine.

This measure does not consider submarine deployments. It disregards the number of submarines on station, in transit, undergoing overhaul, etc., counting only the total number of submarines, regardless of status.

(U) Uncertainties. The number of Soviet SLBM platforms in the inventory for current and past years is known with reasonable accuracy. There is some uncertainty about future estimates which are based upon the assumption of a SAL agreement. These future numbers could vary depending upon options allowed in the agreement and either US or Soviet decisions to place more or less reliance on SLBMs.

(U) A SAL agreement could change either the rate at which new submarines are deployed or the rate at which older submarines are decommissioned or both.

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ICBM AND SLBM LAUNCHERS (U)

What it Measures. This measure is . summation of two previous measures, Intercontinental Ballistic Lau . nd Submarine-Launched Ballistic Missile Launchers. As such, it i. . indication of the total number of strategic ballistic missiles available to each nation. (U)

(U) Limitations. This measure, being the summation of two other measures, (i.e., Intercontinental Ballistic Missile Launchers and Submarine-Launched Ballistic Missile Launchers), incorporates all of the limitations of those two measures.

The measure, by treating both ICBMs and SLBMs in the same manner, has the additional limitation of treating the inherently shorter-range, less

accurate, lower yield, SLBM missiles as the equal of the longer-range, more accurate ICBMs.

(U) Uncertainties. This measure, being the summation of two other measures (i.e., Intercontinental Ballistic Missile Launchers and Submarine-Launched Ballistic Missile Launchers), incorporates all of the uncertainties of those two measures.

(U) Comment. This measure is considered by many analysts as an indication of first strike capability.

INTERCONTINENTAL BOMBERS (U)

What it Measures. The number of intercontinental bombers is totaled. At the 1974 Vladivostok summit, it was agreed that "heavy bombers" would be included in the aggregate ceiling of strategic nuclear delivery vehicles. However, the definition of "heavy bombers" was not specified in the accord. It is the Soviet contention that the BACKFIRE is a medium bomber intended for peripheral/theater missions and should therefore be excluded. US Department of Defense technical assessments of the BACKFIRE performance indicate that this aircraft has the capability of intercontinental missions against the United States. For that reason, the measure includes two trend lines after 1974. (U)

The only US bomber included in both trend lines is the B-52. The solid line for the Soviet bomber force includes only the TU-95 BEAR and the MYA-4 BISON from 1960 to 1978 at which time the BISON is phased out. Commencing in 1979, the solid line includes the BEAR and a projected new long range bomber. The dashed line adds the BACKFIRE bomber to the Soviet force.

(U) Limitations. This measure, by counting the number of intercontinental bombers, disregards the number of aircraft actually available to fly missions. That is, the number of aircraft which are operationally ready and which might survive any prelaunch strike.

This measure does not include bomber force characteristics such as range, weapon mixture, payload capability, penetration capability, delivery accuracy, etc.

Shorter range bombers such as the US FB-111, which are capable of intercontinental missions with in-flight refueling, are not counted in this measure.

US fighter-bombers which are stationed in Europe, which have the capability of striking western portions of the Soviet homeland, are not included in this measure. In a similar manner, US Navy carrier-based aircraft have not been included in this measure.

The Soviets also have approximately 45 BISON aircraft that have been converted from bombers to tankers and approximately 65 BEAR aircraft configured as reconnaissance and ASW aircraft. The Soviets could choose to convert these bomber variant aircraft into bombers. These aircraft have not been included in this measure.

(U) Uncertainties. There is some uncertainty associated with the number or current and past numbers of Soviet intercontinental bombers. Additionally, as noted in the description of the measure, there is no common agreement in regard to the definition of an intercontinental bomber. There is appreciable uncertainty relative to future estimates of Soviet strategic bombers because of the disagreement in the definition of "heavy bombers" and the BACKFIRE production rate.

(U) Comment. USSR bomber levels decrease from 1960 to 1981 as a result of increased emphasis on ballistic missiles (both ICBMs and SLBMs) with no replacement for attrition in the bomber forces. The US increases from 1960 to 1965 reflect the production and deployment of the B-52 and its various versions. From 1965 to 1977 US bomber levels decrease as a result of attrition with no replacement.

STRATEGIC NUCLEAR DELIVERY VEHICLES (U)

What it Measures. The number of ICBM launchers, SLBM launchers, and intercontinental bombers in the inventory is totaled. For example, a MINUTEMAN III ICBM with 3 independently targetable warheads, a POSEIDON SLBM with 10 independently targetable warheads, and a B-52 with 20 SRAM are each counted as one by this measure. As another example, a B-52 with 4 bombs is also counted as one by this measure.

(U) Limitations. This measure, being the summation of three previous measures (i.e., Intercontinental Ballistic Miss. Launchers, Inventory; Submarine-Launched Ballistic Missile Launchers, Inventory; and Intercontinental Bombers, Inventory), incorporates all of the limitations of those three measures.

This measure, by treating all strategic nuclear delivery vehicles the same, has the additional limitation of considering shorter range less accurate SLBMs and less survivable slower bombers the same as ICBMs.

(U) Uncertainties. This measure, being the summation of three previous measures (i.e., Intercontinental Ballistic Missile Launchers, Submarine-Launched Ballistic Missile Launchers, and Intercontinental Bombers), incorporates all of the uncertainties of those three measures.

(U) Comment. After 1976, both forces are assumed to stay within the 2,400 total delivery vehicle limitation in accordance with the informal agreement reached at Vladivostok in 1974. The projections indicate the USSR inventory of strategic nuclear delivery vehicles decreases from a maximum of 2,490 in 1976 to 2,405 in 1978. From that point on, it remains relatively constant.

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B. INDEPENDENTLY TARGETABLE WARHEADS. (U)

1. General. This section addresses the number of independently targetable warheads in the US and USSR strategic inventories. (U)

a. (U) Multiple Warhead Ballistic Missiles. Prior to 1968 strategic missiles had a single warhead. Therefore, an indication of a nation's nuclear missile strike capability could be obtained by simply counting ICBMs and SLBMs. The United States deployed the first multiple warhead ballistic missile in 1964 when the POLARIS A-3 submarine-launched missile became operational. This variant of the POLARIS missile has a range of 2,500 nautical miles and carries a Multiple Reentry Vehicle (MRV) payload. After launch, this missile's payload separates into three separate Reentry Vehicles (RVs) which attack a single target in a fixed pattern. The USS DANIEL WEBSTER was the first POLARIS submarine armed with the MRV A-3 missiles. After 1964, most of the US Navy's 41 ballistic missile submarines were rearmed with this multiple warhead missile.

The next logical step in weapon technology wa[illegible]lopment of the capability to deliver each of the individual warheads independently, against different targets. When the A-3 with its three MRVs went to sea, development was already underway on Multiple Independently targetable Reentry Vehicle (MIRV) warheads. With this type of weapon system, the missile carries a "bus" which contains several RVs. After booster burn out and separation, the bus continues toward enemy territory, dispensing the RVs on a preset program. Each RV can be aimed at a separate target (i.e., independently targeted) within a given area of land or "footprint." The [illegible]'s footprint is dependent upon a number of factors, including missile range, characteristics of the bus dispensing mechanism, and any maneuver[illegible] may be done by the bus. Therefore, the footprint is limited and individual targets must be within the footprint.

The first US operational test of a MIRV system occurred in 1968 with the US MINUTEMAN III ICBM. This MIRV system, with three RVs, replaced 550 of the earlier MINUTEMAN I and II single warhead missiles in the SAC arsenal between 1970 and 1975.

In 1970, the US Navy fired the first submarine-launched MIRVed missile, the POSEIDON C-3. This weapon can deliver up to 14 RVs, has an approximate range of 2,500 nautical miles with a lesser payload, and is the successor to the POLARIS missile. Between 1970 and mid-1977, the Navy converted 31 POLARIS submarines to carry the MIRVed POSEIDON missiles. (The ten oldest POLARIS submarines are not suitable for modification and still carry the A-3 missile.) Further modification of the POSEIDON carrying SSBNs to carry the new MIRVed TRIDENT I missiles will commence in 1979.

The US has no monopoly on technological development of strategic weapons, and in 1968 the USSR began testing the SS-9 SCARP with a MRV warhead. This was followed in the mid-1970s by the development and deployment of MIRVed warheads on the SS-17, SS-18, and SS-19 ICBMs.

Subsequently, the Soviet Navy's YANKEE-class submarines have been credited with carrying the SSN-6 Mod 3 missile, carrying 2 or 3 MRVs, and the DELTA-class submarines can fire the SSN-X-18 and probably later SLBMs with MIRV payloads. The latter missiles, with a range significantly in excess of 4,000 nautical miles, are equivalent or superior in that respect to the US Navy's TRIDENT I SLBM, which is programmed for deployment in 1980-1981, and the proposed TRIDENT II missile, which could become available in the mid-1980s, at the earliest.

b. <u>Bomber Weapon Loadings</u>. The mix of weapons which are carried on a strategic bomber is dependent upon the maximum load carrying capability of the bomber and its mission. Both US and USSR strategic bombers are capable of carrying various types and quantities of gravity bombs and Air-to-Surface Missiles (ASMs). As a result, it is difficult to directly compare the number of bomber-deliverable nuclear weapons. However, as has been done in this section of the report, estimates can be made by assuming maximum weapon loadings in bomb bays and on external mountings. (U)

2. (U) General Limitations and Uncertainties. The measures in this section disregard individual weapon effectiveness and characteristics. Operational characteristics such as reliability, hardness to nuclear effects, readiness, etc., are not considered.

Estimation of the numbers and types of missiles and bombers with their payloads were based on US perception of USSR capabilities. Past quantities are known with some assurance, but future numbers and types of delivery vehicles and therefore numbers of warheads, are uncertain.

3. Measures Considered in This Section:

MIRVed ICBMs
MIRVed SLBMs
MIRVed ICBMs and SLBMs
Independently Targetable ICBM Warheads
Independently Targetable SLBM Warheads
Independently Targetable ICBM and SLBM Warheads
Independently Targetable Bomber Warheads
Independently Targetable ICBM, SLBM, and Bomber Warheads (U)

Page 62 was Deleted.

(U) System and warhead characteristics such as yield, accuracy, reliability, etc., are not considered.

(U) Uncertainties. There is some uncertainty as to the number and types of current Soviet MIRVed ICBMs. Future projections are estimates only and are based upon US perceptions of Soviet capabilities and intentions. These projections are a best estimate assuming a SAL agreement which would place a limit upon the number of ballistic missiles which could be MIRVed.

(U) Comment. MINUTEMAN III, the only US ICBM with a MIRV capability, reached its maximum planned deployment of 550 missiles in 1976. However, the number of MIRVed Soviet ICBMs has continued to increase since their first deployment in 1975.

To date, SAL talks and agreements have addressed numbers and types of ballistic missile launchers and the number of ballistic missiles which could be MIRVed. While the total number of warheads may have been discussed, there has been no indication of any limit on the number of warheads delivered by MIRVed vehicles.

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(U) Uncertainties. There is some uncertainty as to the number and types of current and past Soviet MIRVed SLBMs. Future projections are estimates only and are based upon US perceptions of Soviet capabilities and intent. These projections are a best estimate assuming a SAL agreement which would limit the number of MIRVed ballistic missiles.

(U) Comment. Between 1970 and 1976 the US replaced the POLARIS missile with the MIRVed POSEIDON missile in 31 SSBNs. The remaining 10 US SSBNs were not modified to accept the larger POSEIDON missile because their launching tubes were smaller and therefore extensive modification to both the submarine and missile tube would have been required. The US plans to introduce the TRIDENT C-4 missile in 1980-81. This will be done in two ways. First, by replacing POSEIDON missiles with the C-4, and second, by the addition of TRIDENT submarines (with the eventual decommissioning of the 10 POLARIS submarines). The USSR inventory of MIRVed SLBMs will also probably continue to increase due to retrofit, modernization, and new construction programs.

MIRVed ICBMs AND SLBMs (U)

<u>What it Measures</u>. The number of MIRVed ICBMs and SLBMs is totaled. (U)

(U) Note: The US started to MIRV its systems in 1970 but since the USSR did not deploy MIRVed systems until 1975, the measure depicts MIRVed ICBMs and SLBMs since 1974.

(U) <u>Limitations and Uncertainties</u>. This measure, being the summation of two previous measures, is subject to the same limitations and uncertainties of those measures (MIRVed ICBMs and MIRVed SLBMs). Additionally, it has the further limitation of treating ICBMs and SLBMs as equals.

(U) <u>Comment</u>. The informal agreement reached at Vladivostok in 1974 set an upper limit of 1,320 MIRVed ICBMs and SLBMs. Within the proposed limitations,

either side may elect to place more reliance on 'BMs than in the past. Additionally, with no limit being considered on the number of RVs per MIRVed warhead, the total number of warheads may change drastically in the future.

INDEPENDENTLY TARGETABLE ICBM WARHEADS (U)

What it Measures. The number of independently targetable warheads associated with ICBM boosters is totaled. For example, an ICBM with three Multiple Independently targetable Reentry Vehicles (MIRVs) is counted as 3 in this measure, whereas an ICBM with a single warhead is counted as 1. An ICBM with three MRV (separate reentry vehicles which are delivered in a fixed pattern about a single aim point) is also counted as 1. The ICBM force level is determined by counting missile launchers, regardless of status. In a sense then, this is a measure of the number of separate aim points an ICBM force could target were all of its missiles operational. (U)

(U) The total number of Soviet reentry vehicle warheads is based upon our perception of the number of missile launchers and assumptions concerning the number of MIRVed vehicles associated with these launchers. The possibility that some of these launchers may have a refire capability has not been considered.

(U) A portion of the Soviet missile sites are undergoing upgrade or conversion at any time. Hence, our estimate of what independent reentry vehicle warheads may be associated with these sites and our knowledge of the number of launching sites in such a status affects the total number of RV warheads which are actually available at any time.

(U) Uncertainties. The current and past numbers of Soviet ICBM launchers are known with reasonable accuracy. There is a degree of uncertainty associated with the number of MIRVed Soviet ICBMs and number of warheads per MIRVed ICBM. There is also a degree of uncertainty associated with the numbers of future Soviet ICBM launchers. These numbers will depend upon any SAL agreement and Soviet options and decisions to exchange ICBMs for SLBMs.

(U) Comment. In 1976, with the completion of the MINUTEMAN III deployment, the US inventory of independently targetable ICBM warheads reached its current level of 2,154. The USSR inventory, on the other hand, has continued to increase as older un-MIRVed systems have been replaced with newer MIRVed systems.

INDEPENDENTLY TARGETABLE SLBM WARHEADS (U)

What it Measures. The number of independently targetable warheads associated with Submarine-Launched Ballistic Missiles (SLBMs) is totaled. For example, the US POSEIDON SLBM with ten MIRVs is counted as 10 in this measure, whereas the Soviet SSN-6 Mod 1 SLBM with one warhead is counted as 1. However, the US POLARIS A-3 SLBM with three MRVs (separate reentry vehicles which are delivered in a fixed pattern about a single aim point) is counted as 1. The SLBM force level has been determined by counting SLBM-equipped submarines, regardless of status. In a sense then, this is a measure of the number of separate aim points an SLBM force could target were all of its submarines and missiles operational and were all of its submarines within launching range. (U)

(U) The number and type of SLBM submarines is not considered by the measure.

(U) Uncertainties. The number of Soviet SLBM platforms (and hence number of boosters) in the inventory for current and past years is known with reasonable accuracy. However, there is some uncertainty about the number of MIRVed Soviet SLBMs which affect the calculations upon which the totals are based. The estimate of future numbers of Soviet SLBMs could vary depending upon any SAL agreement and Soviet options for decisions to replace ICBMs with SLBMs.

(U) Comment. Both nations' inventory of independently targetable SLBM warheads has continued to increase throughout the time period addressed. Initially, this was caused by the increasing number of ballistic missile submarines deployed by each nation, and later by replacement of un-MIRVed SLBMs with MIRVed SLBMs.

INDEPENDENTLY TARGETABLE ICBM AND SLBM WARHEADS (U)

<ins>What it Measures</ins>. The number of independently targetable reentry vehicles associated with all of the ICBMs and SLBMs in the inventories is totaled. In a sense, this is a measure of the total number of separate aim points which could be targeted by an ICBM and SLBM force were all of its missile launchers operational and all SSBNs on station. (U)

(U) <ins>Limitations and Uncertainties</ins>. This measure, being the summation of two previous measures (i.e., Independently Targetable ICBM Warheads and Independently Targetable SLBM Warheads), incorporates all of the limitations and uncertainties of those two measures.

The measure, by treating all warheads the same, has the additional limitation of treating the shorter range, less accurate, SLBM as the equal of the intercontinental range, more accurate ICBM.

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INDEPENDENTLY TARGETABLE BOMBER WARHEADS (U)

<u>What it Measures</u>. The number of independently targetable strategic bomber weapons (bombs and ASMs) is totaled. Strategic bomber inventories and maximum bomber loading consistent with both aircraft characteristics and weapon availability (where known) have been used. In a sense, this is a measure of the total number of separate aim points which could be targeted by a bomber force were all of its bombers operational and loaded to the maximum consistent with weapons available. (U)

(U) <u>Limitations</u>. This measure, being an extension of a previous measure (i.e., Intercontinental Bombers) incorporates all of the limitations of that measure.

Operational bomber loadings are dictated by mission assignment and may vary greatly from maximum possible loading.

This measure has the additional limitation of treating gravity bombs the same as ASMs. It ignores weapon yield, delivery accuracy, and, in the case of ASMs, weapon range.

The total number of bombs and ASMs available at any given time may be greater or less than the entire bomber force's capacity.

(U) Uncertainties. This measure, being an extension of a previous measure (Intercontinental Bombers), incorporates all of the uncertainties of that measure. There is appreciable uncertainty relative to numbers of Soviet bombs and ASMs available.

(U) Comment. The number of bomber weapons available to a force is much harder to determine than the number of ballistic missiles. Nuclear weapon storage sites may or may not be collocated with the normal bomber bases or at dispersal airfields. Weapon storage and availability may be directly related to the aircraft mission and have little relation to the maximum load capability of the bomber. On the other hand, bomber missions may be planned to try to take advantage of maximum bomber loading. Therefore, comparisons of bomber weapons must address maximums, realizing these comparisons are upper limits and therefore probably overstated.

The US bomber force, and therefore independently targetable bomber weapons, increased until 1965, after which time there was a decrease in the number of bombers until the late 1970s. Although the number of US bombers remains constant after 1977, introduction of the ALCM in 1980 will dramatically increase the number of warheads.

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INDEPENDENTLY TARGETABLE ICBM, SLBM, AND BOMBER WARHEADS (U)

What it Measures. The number of independently targetable reentry vehicles associated with ICBMs and SLBMs plus bomber-delivered bombs and ASMs is totaled. In a sense, this measure totals the number of separate aim points which could be targeted by an offensive strategic force were all of its missiles and bombers operational. (U)

(U) Limitations and Uncertainties. This measure, being the summation of three previous measures (i.e., Independently Targetable ICBM Warheads; Independently Targetable SLBM Warheads; and Independently Targetable Bomber Weapons), incorporates all of the limitations and uncertainties of those three measures.

This measure has the additional limitation of treating ICBMs, SLBMs, bombs, and ASMs as equals regardless of range, accuracy, or yield.

Comment. A comparison of the total number of independently targetable warheads in each inventory without due consideration of all the various system characteristics can be misleading. Equating ICBM RVs, SLBM RVs, and bombs ignores too many variables. (U)

(U) Two figures are provided below to illustrate the total number and types of independently targetable ICBM, SLBM, and Bomber Warheads through the period covered by this report. Figure II-16 illustrates the US strategic independently targetable warhead force composition, and Figure II-17 illustrates the Soviet force composition.

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C. THROW-WEIGHT. (U)

1. (U) General. This section addresses the throw-weight of the US and USSR ICBM inventories. Throw-weight includes the weight of the warhead(s), any penetration aids, dispensing mechanisms, bus, fuel used for maneuvering, etc. It reflects the weight-throwing capacity of a ballistic missile and is, therefore, a measure of the weight of the part of the missile above the last boost stage.

Since throw-weight is generally related to missile size, a comparison of SLBMs which are limited by submarine size, has not been included.

2. (U) Limitations and Uncertainties. The correlation between warhead weight and throw-weight or payload varies with individual weapon types and configurations. Addressing throw-weight by itself ignores other indicators of weapon effectiveness such as warhead yield, accuracy, etc., in addition to the operational constraints of individual weapon types. For a discussion of missile yield to weight relationships see Appendix A.

Throw-weight can be used as a measure of the potential for increasing the number of warheads. As a counterforce indicator, throw-weight relates very roughly to weapon yield but not to delivery accuracy which is more important when considering counterforce capabilities. Throw-weight's rough relation to yield is an overall indicator of countervalue potential. However, in today's world of MRVs and MIRVs, throw-weight's relation to yield and equivalent megatonnage (and therefore to fallout and blast) is diminishing. As a result, the relation of throw-weight to urban-industrial damage potential is increasingly invalid.

There is uncertainty as to the payload or throw-weight of Soviet systems, and figures are based on US perceptions. Furthermore, the future numbers and types of delivery vehicles are dependent upon SAL agreements and options contained within them.

3. Measure Considered in This Section:

ICBM Throw-Weight (U)

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(U) The calculations presented in this measure are based upon the premise that all weapons are reliable. This, of course, is not the case. Additionally, at almost any time some proportion of a nation's ICBM force is not operational. For instance, an ICBM may be off line for such reasons as testing, maintenance, upgrade, or conversion. Hence, the measure tends to overstate the total throw-weight of both nations.

(U) The measure does not include other factors of ICBM system and missile effectiveness. For example, weapon yield, accuracy, silo hardness, reaction time, etc., are disregarded.

(U) The measure does not include a comparison of the relationships between throw-weight, range, and payload.

(U) Uncertainties. The calculations are based in part upon our perception of the throw-weight associated with Soviet ICBMs. The number of past and current Soviet ICBM systems is known with reasonable accuracy. Future estimates of Soviet ICBMs are less certain. These estimates are based upon the assumption of a SAL agreement but will depend upon Soviet options and decisions relative to the ICBM force. There is a significant degree of uncertainty associated with our perception of the throw-weight capability of these systems.

(U) Comment. The Protocol to the May 26, 1972 Interim Agreement on strategic arms limitations states that there shall be no conversion of "light" ICBMs to "heavy" ICBMs, although there were no agreed upon definitions of "light" or "heavy". The TITAN II is considered to be the only "heavy" US ICBM, whereas the SS-7, SS-8, SS-9, SS-18, and SS-19 Soviet ICBMs are all considered "heavies". Future SAL agreements may also address throw-weight limitations. To be specific, however, both sides must agree upon a set of definitions which could be used to determine compliance with the agreement.

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D. SLBM MAXIMUM RANGE. (U)

1. (U) General. The maximum range of SLBMs in one force is compared to the maximum range of SLBMs in the other force.

This comparison provides an indication of both potential target coverage and size of submarine operation area. The longer the range of the SLBMs the wider the choice of targets from a given operating area, or conversely, for the same target set the potential operating area increases.

The total ocean area is about ten times the combined land area of the United States and the Soviet Union. If the range of SLBMs in either nation's arsenal permits the use of only ten percent of the total ocean area as ballistic missile submarine operating area, the Anti-Submarine Warfare (ASW) problem is immense. On the average, if all submarines were on station, each submarine would have over 150,000 square miles of ocean in which to operate.

Since ICBMs are defined as having ranges of 3,000 to 8,000 nautical miles and can reach targets in the other nation's homeland, a comparison of the range capability of these systems is meaningless.

2. (U) General Limitations and Uncertainties. All other measures of SLBM effectiveness are disregarded including any operational constraints on an SLBM force. Further, the measure only reflects the maximum range of any SLBM in the force. It does not provide any indication of the number of SLBMs with that range.

There is some uncertainty as to the actual ranges of Soviet SLBM systems.

3. Measure Considered in This Section:

SLBM Maximum Range (U)

SLBM MAXIMUM RANGE (U)

What it Measures. The maximum range of one nation's SLBMs is plotted against the maximum range of the other nation's SLBMs. For example, in 1973 the Soviet Union introduced the 4,200+ nautical mile SSN-8 SLBM. At that time the POSEIDON C-3 missile, with a nominal range of 2,500 nautical miles, was the longest range US SLBM. (U)

(U) The measure disregards other measures of SLBM force effectiveness such as alert rate, accuracy, yield, etc.

(U) Uncertainties. There is some uncertainty associated with the year of introduction of Soviet SLBM systems. There is a greater degree of uncertainty as to the maximum range of Soviet SLBM systems. For future years, our perception of both US and Soviet SLBM technological improvements introduces additional uncertainties.

(U) Comment. In general, major improvements in the area of SLBM range are presently limited by submarine size and missile-propellent technology.

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E. GROSS YIELD. (U)

1. (U) General. This section compares the total nuclear yield of the strategic nuclear forces.

Yield of nuclear weapons is a measure of the explosive energy that can be released by the weapon. It is common practice to state this in terms of the equivalent quantity of TNT required to produce the same explosive force. Thus, a yield of one kiloton (KT) is equivalent to 1,000 tons of TNT. One megaton (MT) is equivalent to 1,000,000 tons of TNT or 1,000 KT. The nuclear weapons exploded over Nagasaki and Hiroshima in 1945 had yields of approximately 20 KT. Most early strategic missiles had yields measured in the megaton range. Technological improvements increased the delivery accuracy while MRV and MIRV systems decreased the available weight for individual warheads using the same boosters. In other words, these two facts first permitted and then required fabrication of smaller yield weapons so that today, the individual warhead yield of many strategic systems has been reduced and is measured in kilotons.

The gross yield of the strategic bomber forces reflect only the maximum total yield which could be delivered based upon aircraft design and weapon availability. Actual aircraft loading is mission rather than design oriented and is in part dictated by the amount of fuel carried by the aircraft and the distance to the target. In addition, each bomber can normally carry a large variety of bombs and/or ASMs.

2. (U) General Limitations and Uncertainties. A force comparison based upon the gross yield of the weapons fails to consider other measures of weapon effectiveness such as reliability, readiness, accuracy, etc.

Gross yields of bomber forces reflect the maximum weapon loads that could be delivered. However, any aircraft loading is mission rather than design oriented, and any comparison of gross yield based upon aircraft capabilities can be misleading.

Gross Yield has been used as a measure of urban-industrial damage potential. As a measure of blast potential, the measure fails to account for target structure, height of burst, and the variation in blast effects

with individual yields. As a measure of fallout potential, the measure ignores the fission fraction, the population distribution, shelter and types of structures, and wind speed and dispersive characteristics [illegible] of these characteristics greatly influence urban-industrial damage.

Numbers and yields of Soviet weapons are based [illegible] perceptions and estimates. Future numbers are dependent upon any SAL agreements and options therein.

3. Measures Considered in This [illegible]

ICBM Gross Yield
SLBM Gross Yield
ICBM and SLBM Gross Yield
Bomber Gross Yield
ICBM, SLBM, and Bomber Gross Yield (U)

Pages 91 and 92 were Deleted.

(U) The total value (gross yield) of Soviet ICBMs is based upon our perception of the type and number of observed ICBM launching sites. As a result, the possibility that some sites may be capable of launching more than one ICBM is not considered in the measure.

(U) Uncertainties. While there is little uncertainty associated with current and past numbers of Soviet ICBM launchers, there is a greater degree of uncertainty associated with the type and yield of the warheads associated with specific ICBM systems.

Since some of the Soviet ICBM systems are deployed in different configurations, there is uncertainty as to the number of MIRVed ICBMs as well as the yield and number of warheads on these missiles.

Future estimates, which affect the totals, are based upon the assumption of a SAL agreement which would place a limitation on the number of strategic nuclear delivery vehicles as well as MIRVed launchers.

(U) Comment. Originally, both the US and the USSR deployed large yield warheads on their ICBMs. With the introduction of MIRV capabilities and improved delivery accuracy, newer systems have generally had smaller yield warheads.

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(U) The total value (gross yield) of Soviet SLBMs is based upon our perception of the type and number of observed submarines.

(U) Uncertainties. While there is little uncertainty associated with current and past numbers of Soviet SLBM launchers, there is a greater degree of uncertainty associated with the type and yield of the warheads associated with specific SLBM systems. Since some of the Soviet SLBM systems are deployed in different configurations, there is uncertainty as to the number of MIRVed SLBMs as well as the yield and number of warheads on these missiles.

ICBM AND SLBM GROSS YIELD (U)

What it Measures. This measure is a comparison of the total yield of all the ICBM and SLBM warheads in the force. (U)

(U) Limitations and Uncertainties. This measure, being the summation of two previous measures (i.e., ICBM Gross Yield and SLBM Gross Yield), incorporates all of the limitations and uncertainties of those two measures.

(U) Comment. The comments pertinent to the two previous measures (i.e., ICBM Gross Yield and SLBM Gross Yield), apply to this measure.

Due to the numbers and yields of ICBMs in both forces, the major contribution to this measure is from the ICBMs.

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BOMBER GROSS YIELD (U)

(U) For the US, the number of weapons available did not always allow maximum loading of all bombers. When that occurred, weapon inventory was used as the limiting factor.

(U) The total value (gross yield) of Soviet bombers is based upon our perception of the type and number of Soviet bomber forces. It was assumed that there were enough bombs and ASMs to fully load all Soviet bombers.

(U) Uncertainties. While there is little uncertainty associated with the actual numbers of Soviet bombers, there is a great deal of uncertainty with the number, type, and yields of warheads associated with these bombers. Future estimates of Soviet bombers are dependent on Soviet options in any SAL agreements.

(U) Comment. There are many combinations of bombs and ASMs which can be carried by the bombers in both forces. In addition, bombs are available in a range of yields from a few kilotons to multi-megatons. For this and other measures which apply to bomber weapons, bombs were assumed to have a 1.0 MT yield.

ICBM, SLBM, AND BOMBER YIELD (U)

What it Measures. The yield of ICBM, SLBM, and bomber warheads is totaled. (U)

(U) Limitations and Uncertainties. This measure, being the summation of three previous measures (i.e., ICBM Gross Yield, SLBM Gross Yield, and Bomber Gross Yield), incorporates all of the limitations and uncertainties of those three measures.

(U) Comment. The comments pertinent to the measures which are summed for this measure (i.e., ICBM Gross Yield, SLBM Gross Yield, and Bomber Gross Yield), also apply to this measure.

For the US, the greatest contribution to this measure from 1960 to 1975 is from the bomber force. After 1975, the contributions from the bomber force and ICBM force are about equal. The USSR, however, has its greatest contribution from the ICBM force throughout the period.

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F. EQUIVALENT MEGATONS. (U)

1. (U) General. This section compares the Equivalent Megatons (EMT) of the strategic nuclear forces. EMT is a measure of blast effects against urban-industrial targets. This measure takes into account the fact that a weapon's destructive power does not grow linearly with an increase in weapon yield. For the same target, a 25 megaton (MT) weapon is not 25 times as destructive as a 1 MT weapon.

Accordingly, in order to estimate the destructive capability of large weapons, the yield is taken to some fractional power (i.e., Y^x, where $x<1$). This formulation reflects the fact that blast is spherical in nature and a significant portion of the nuclear weapon effects are harmlessly directed upward into the atmosphere rather than along or into the ground. An additional assumption is that the potential target area is not smaller than the resulting lethal area of the weapon. If the lethal area of the weapon is larger than the target area, EMT overestimates the weapon's damage potential. Various values have been used for x, ranging from 0.3 to 0.8. These adjustments can be made to take into account the varying characteristics of both weapon types and targets. In this section, x has been chosen to be equal to two-thirds for yields less than 1 MT. For yields larger than 1 MT, since the lethal area of a weapon will exceed the size of most urban-industrial target areas, a lower value of x (i.e., x = 1/2) has been used. Mathematically, this becomes:

$$EMT = Y^x$$

where: Y is measured in MT

and $x = 0.67$ for $Y<1$

$x = 0.5$ for $Y \geq 1$ MT

For example, a 100 KT warhead is valued as 0.22 EMT and a 10 MT warhead is valued as 3.16 by this measure.

The comparison of the EMT of the bomber forces of both nations is based upon the assumptions concerning loadings described in Section D, Independently Targetable Warheads, and in Section E, Gross Yield.

2. (U) General Limitations and Uncertainties. Equivalent Megatons is a measure of urban-industrial damage; however, as formulated, EMT tends to overestimate the amount of damage. The exponent in the calculations should be dependent in a non-linear fashion on the yield of the weapon, the target size, and target composition; however, as formulated the exponent is solely a function of weapon yield. The major factor in the overestimation is simply that, with the exception of major cities, a nuclear blast area can easily exceed the size of the city. Other factors of individual weapon characteristics and effectiveness as well as operational constraints on the delivery systems are also not considered by this measure.

There is uncertainty as to the numbers and yields of Soviet warheads.

3. Measures Considered in This Section:

ICBM Equivalent Megatons
SLBM Equivalent Megatons
ICBM and SLBM Equivalent Megatons
Bomber Equivalent Megatons
ICBM, SLBM, and Bomber Equivalent Megatons (U)

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ICBM EQUIVALENT MEGATONS (U)

<u>What it Measures</u>. This measure sums the Equivalent Megatons (EMT) of all the ICBMs in the force. (U)

<u>Limitation</u>.. EMT is a valid measurement of blast capability against urban-industrial area targets; however, it is not a valid measure against point targets and/or hardened targets. (U)

(U) The total values of EMT attributed to Soviet ICBMs are based upon our perception of the type and number of Soviet ICBM launchers. As a result, the possibility that some launchers may be capable of launching more than one missile is not included in the measure.

(U) Uncertainties. There is little uncertainty associated with current and past numbers of Soviet ICBM launchers. There is, however, a degree of uncertainty associated with the type and yield of Soviet missile warheads. There is also uncertainty in the future estimates of MIRVed ICBMs and the number of warheads associated with each ICBM. Future projections are based upon the assumption of a SAL agreement which would place a limitation on the number of delivery vehicles and MIRVed ICBMs.

A portion of launching sites is undergoing overhaul/upgrade or conversion at any given time. Hence our estimate of which warheads may be associated with these sites affects the total EMT calculation.

(U) Comment. Using a single set of exponents in comparing the two forces does not consider the differences between US and Soviet urban area characteristics. Civil defense measures, construction, and dispersion all contribute to these differences.

SLBM EQUIVALENT MEGATONS (U)

<u>What it Measures</u>. This measure sums the Equivalent Megatons (EMT) of all the SLBMs in the force. (U)

<u>Limitations</u>. EMT is a valid measurement of blast capability against urban-industrial area targets; however, it is not a valid measure against point targets and/or hardened targets. (U)

(U) The total values of Soviet EMT is based upon our perception of the type and number of SLBM launchers.

(U) Uncertainties. The current and past numbers of Soviet SLBM launchers is known with reasonable accuracy. There is some uncertainty relative to future estimates of Soviet MIRVed SLBMs and the number of warheads associated with each SLBM. Future estimates are based upon the assumption of a SAL agreement which would place a limitation on the number of SLBMs. There is also a degree of uncertainty associated with the type and yield of the warheads on these missiles.

A number of submarines may be undergoing overhaul and/or conversion at any given time. Hence, estimates of what warheads may be associated with these submarines affects the total EMT calculation.

(U) Comment. Although the smaller yield (less than 1 MT) warheads or most US SLBMs gain in value by this measure, large cities still would probably require targeting by more than one SLBM. This complicates the targeting problem because of fratricide and timing considerations.

ICBM AND SLBM EQUIVALENT MEGATONS (U)

What it Measures. This measure sums the Equivalent Megatons (EMT) of all the ICBMs and SLBMs in the force. (U)

(U) Limitations and Uncertainties. This measure, being the summation of two previous measures (i.e., ICBM Equivalent Megatons and SLBM Equivalent Megatons), incorporates all of the limitations and uncertainties of those two measures.

(U) Comment. In addition to the comments applicable to the previous two measures, which are also appropriate to this measure, combining ICBMs and SLBMs into a single measure disregards differences in operational considerations that exist between the two separate weapons systems.

Page 111 was Deleted.

BOMBER EQUIVALENT MEGATONS (U)

What it Measures. This measure sums the Equivalent Megatons (EMT) of all strategic bomber offensive nuclear weapons. (U)

Limitations. While EMT is a measure of blast damage against urban-industrial targets, it is not a valid measure against point and/or hardened targets. (U)

(U) Assumptions concerning bomber loading were addressed under Bomber Gross Yield in Section E of this Chapter.

(U) Uncertainties. Current and past numbers of Soviet bombers are known with some accuracy. However, the number and yield of weapons used in bom. .rs are subject to a wide range and hence there is a great deal of uncertainty as to both the US and Soviet values. However, since the same basic assumptions have been made with regard to weapon loading, this measure represents an upper limit for both forces.

(U) Comment. Just as in any measure of bomber weapon capabilities, total bomber EMT is dependent upon the assumptions made concerning bomber weapon loading. With the large number of different yield weapons available, such assumptions can introduce large errors.

ICBM, SLBM, AND BOMBER EQUIVALENT MEGATONS (U)

What it Measures. This measure sums the Equivalent Megatons (EMT) of all ICBM, SLBM, and bomber forces. (U)

(U) Limitations and Uncertainties. This measure, being the summation of three other measures (i.e., ICBM Equivalent Megatons, SLBM Equivalent Megatons, and Bomber Equivalent Megatons), incorporates all of the limitations and uncertainties of those three measures.

(U) Comment. The comments applicable to the three previous measures which make up this measure are also appropriate to this measure. Additionally, this measure does not consider the differences in delivery vehicle and/or launcher characteristics.

G. LETHAL AREA POTENTIAL. (U)

1. General. This section compares the total lethal area potential of the strategic nuclear forces. The lethal area potential, as defined here, is the area on the earth's surface which will be covered with at least 15 psi of overpressure when a weapon is detonated at its optimum height of burst for maximum blast overpressure. This area is expressed in square nautical miles in this report. (U)

(U) Lethal area potential provides an estimate of the capability of nuclear weapons against soft area targets. Hence lethal area potential like EMT may be used as a measure of capability against urban-industrial targets.

The value of 15 psi has been arbitrarily selected; however, the following effects are observed at that overpressure: (U)

15 psi Overpressure Effects (U)

Threshold of Lung Hemorrage	
Skull Fracture ≥ 50%	(translation effects)
Lethality ≤ 1%	(translation effects, persons in the open)
Lethality > 30%	(translation effects, persons near structures)

At least 90% probability of severe damage to:
- Single and multistory wood framed buildings
- Single and multistory masonry buildings
- Single and multistory reinforced concrete buildings.

2. (U) General Limitations and Uncertainties. As a measure of urban-industrial damage, lethal area potential usually overestimates the amount of damage. This is because the blast area may exceed the size of the target area and because the amount of actual damage within the blast area is dependent upon other factors such as target composition. Appendix B discusses the US and USSR urban-industrial target sets which must also be considered in attack planning. Other than yield, individual weapon characteristics, effectiveness, and operational constraints are not considered by this measure.

There is uncertainty as to the numbers and yields of Soviet warheads.

3. Measures Considered in This Section:

ICBM Lethal Area Potential
SLBM Lethal Area Potential
ICBM and SLBM Lethal Area Potential
Bomber Lethal Area Potential
ICBM, SLBM, and Bomber Lethal Area Potential (U)

ICBM LETHAL AREA POTENTIAL (U)

What it Measures. The total lethal area potential of the US and USSR ICBM forces is compared. The area, measured in square nautical miles (n.m.^{2}), subjected to at least 15 psi overpressure is determined for each weapon and then summed over the force. Each weapon is assumed to be detonated at its optimum height of burst for blast overpressure. (U)

(U) Limitations. Although this measure provides an indication of the total area which may be subjected to a given overpressure by all of the ICBMs in the force, it does not take into account synergistic effects resulting from other nearby weapon bursts.

This measure fails to take into account other weapon systems characteristics. Factors such as prelaunch survivability, alert rate, reliability, accuracy, etc., are not considered in this measure.

The measure also does not consider specific target types or hardness.

(U) Uncertainties. The 15 psi blast contour is a function of weapon yield. Hence, any uncertainty in weapon yield is a primary cause of uncertainty in this measure. Since blast overpressure has been summed across each nation's force, uncertainties associated with the numbers and types of warheads also contribute to the uncertainties of this measure. There is a degree of uncertainty associated with the yield and number of warheads (in the case of MIRVed ICBMs) of present and future Soviet ICBMs. There is little uncertainty associated with current and past numbers of Soviet ICBM launchers. Future estimates are based upon a SAL agreement which would limit the number of ICBMs and the number which may be MIRVed.

(U) Comment. A comparison of the two forces using lethal area potential as the measure, tends to bias the results towards the force with larger yield warheads. If all other force characteristics were identical, this would not be an inappropriate measure. However, weapon system delivery accuracy, reliability, numbers of warheads, target construction, and targeting philosophy all may interact to negate the advantage shown by this measure.

SLBM LETHAL AREA POTENTIAL (U)

What it Measures. The total lethal area potential of the US and USSR SLBM force is compared. The area, measured in square nautical miles (n.m.^{2}), subjected to at least 15 psi overpressure is determined for each weapon and summed over the force. Each weapon is assumed to be detonated at its optimum height of burst for blast overpressure. (U)

(U) Limitations. Although this measure provides an indication of the total area which may be subjected to a given overpressure by all of the SLBMs in the force, it does not take into account synergistic effects resulting from other nearby weapon bursts.

This measure fails to take into account other weapons systems characteristics. Factors such as prelaunch survivability, submarine deployments, alert rate, reliability, accuracy, etc., are not considered in this measure. The measure also does not consider specific target types or hardness.

(U) Uncertainties. There is a degree of uncertainty relative to the yield of Soviet SLBMs. Since lethal area is calculated from yield such uncertainty could be a major factor in the accuracy of the lethal area calculation. There is little uncertainty associated with current and past numbers of Soviet SLBM launchers; however, there is uncertainty associated with the types of future Soviet SLBMs and the number and types of warheads. Future estimates are based upon a SAL agreement and will vary depending upon Soviet decisions relative to options contained therein.

(U) Comment. A measure such as lethal area potential which addresses only one characteristic of a force can be misleading. The measure of SLBM lethal area potential indicates that the advantage shifted to the USSR in about 1974 and continues to favor them through 1986. This is true, even though the US has a substantial lead in the numbers of SLBM warheads throughout the entire period with an advantage of more than 3-to-1 in 1986. This numerical advantage in warheads permits the US to strike three times as many targets with its SLBM force. With target dispersion, one means of civil defense, a larger number of smaller yield weapons may be more advantageous.

ICBM AND SLBM LETHAL AREA POTENTIAL (U)

What it Measures. This measure sums the lethal area potential (15 psi) for all the ICBMs and SLBMs in the force. (U)

(U) Limitations and Uncertainties. This measure, being the summation of two previous measures (i.e., ICBM Lethal Area Potential and SLBM Lethal Area Potential), incorporates all of the limitations and uncertainties of those two measures.

Also, by treating all warheads the same, there is the additional limitation of treating the shorter range, less accurate SLBM as the equal of the longer range, more accurate ICBM.

(U) Comment. The greatest contribution to the Soviet lethal area potential in this combined measure is from the ICBM force. This is due to the greater number and higher yields of Soviet ICBMs compared to Soviet SLBMs. For the US however, the contribution from ICBMs is about the same as that from SLBMs.

BOMBER LETHAL AREA POTENTIAL (U)

<u>What it measures</u>. The total lethal area potential of the US and USSR bomber forces is compared. The area, measured in square nautical miles (n.m.^{2}), subjected to at least 15 psi overpressure is determined for each weapon and summed over the force. Each weapon is assumed to be detonated at its optimum height of burst for blast overpressure. (U)

<u>Limitations</u>. Although this measure provides an indication of the total area which may be subjected to a given overpressure by all of the bombs and ASMs in the force, it does not take into account synergistic effects resulting from other nearby weapon bursts. (U)

(U) This measure fails to take into account other weapon system characteristics. Factors such as prelaunch survivability, alert rate, bomber penetrability, reliability, accuracy, etc., are not considered in this measure.

(U) The measure also does not consider specific target types or hardness.

(U) Uncertainties. There is a large degree of uncertainty associated with the number and yield of bombs and ASMs carried by present and future Soviet bombers. There is also a degree of uncertainty associated with the number and yields of future US bomber weapon loadings. As lethal area has been calculated from weapon yield and then summed across the bomber force, this uncertainty has been compounded and is based upon our perception of weapon loading. There is little uncertainty associated with current and past numbers of Soviet bombers; however, there is some uncertainty associated with the numbers and types of future Soviet bombers.

(U) Comment. This measure of bomber capability, like all other measures of bomber capabilities in this report, is based upon the earlier assumptions used concerning bomber loading.

ICBM, SLBM, AND BOMBER LETHAL AREA POTENTIAL (U)

What it Measures. This measure sums the lethal area potential (15 psi) for all the ICBMs, SLBMs, and bombers in the force. (U)

(U) Limitations and Uncertainties. This measure, being the summation of of three previous measures (i.e., ICBM Lethal Area Potential, SLBM Lethal Area Potential, and Bomber Lethal Area Potential), incorporates all of the limitations and uncertainties of those three measures.

(U) Comment. The comments to those measures which are summed for this measure are applicable here. Additionally, it should be noted that the greatest contribution to the total Soviet lethal area potential (more than 70%) is from the ICBM force.

H. WEAPON SYSTEM ACCURACY. (")

1. (U) General. This section compares the accuracy of US and USSR strategic weapon systems. The accuracy of weapon systems is normally measured and expressed as Circular Error Probable (CEP). The CEP is the radius of a circle centered on a target within which 50% of the weapons will impact.

This section addresses two separate measures of weapon system accuracy. The first is an accuracy comparison of US and USSR ICBMs and SLBMs, which compares the best accuracy of these systems as a function of time. These comparisons reflect the comparative state of ballistic missile guidance technology. The second measure compares the average accuracy of the US and USSR strategic forces (ICBMs, SLBMs and bombers).

2. (U) General Limitations and Uncertainties. These measures depict the estimated CEP for arriving weapons; therefore, relevant factors such as reliability, survivability, penetrability and accuracy of target location are not considered. Appendix C contains a discussion of targeting uncertainties. Possibly of greater significance is the uncertainty of the validity of estimates of ballistic missile accuracy. For example, there are restrictions on launch sites, trajectories and impact areas for testing US ballistic missiles and Soviet accuracies are based on intelligence data, estimates and projections.

3. Measures Considered in This Section:

Accuracy Comparison (1/CEP) US and USSR ICBMs
Accuracy Comparison (1/CEP) US and USSR SLBMs
Average Accuracy of the ICBM Force
Average Accuracy of the SLBM Force
Average Accuracy of the Combined ICBM and SLBM Force
Average Accuracy of the Total Strategic Force (ICBMs, SLBMs, and Bombers) (U)

ACCURACY COMPARISON (1/CEP) US AND USSR ICBMS (U)

What it Measures. The reciprocal of the CEP (i.e., 1/CEP), measured in nautical miles, of the most accurate US ICBM at a given point in time is plotted against the reciprocal of the CEP of the most accurate Soviet ICBM at the same point in time. Therefore, this plot attempts to depict the comparative state of guidance technology. (U)

(U) Limitations. This measure, which displays 1/CEP of only the most accurate ICBM, disregards the accuracy of all other ICBMs in the force at that point in time. Since the most accurate ICBM is often the newest ICBM in the inventory, the curve is sensitive to the introduction of a new weapon system which would usually represent only a small portion of a nation's ICBM force in the year indicated by the measure.

The measure disregards all other measures of ICBM force effectiveness such as, prelaunch survivability, warhead yield, MIRV or MRV capability, hardness to nuclear effects, number of missiles, etc.

(U) Uncertainties. There is a degree of uncertainty associated with the accuracy and year of introduction of past and current Soviet missile systems. Future estimates are based upon a perception of the technological improvements in Soviet missile systems and have a greater degree of uncertainty.

(U) Comment. Accuracy can be improved with hardware or software changes. These changes may or may not be observable in the deployed forces. The improved accuracy of a new system may, therefore, be incorporated into an older one without being observed.

ACCURACY COMPARISON (1/CEP) US AND USSR SLBMS (U)

What it Measures. The reciprocal of the CEP (i.e., 1/CEP), measured in nautical miles, of the most accurate US SLBM at a point in time is plotted against the reciprocal of the CEP of the most accurate Soviet SLBM at the same point in time. Therefore, this plot is an attempt to depict the comparative state of guidance technology. (U)

(U) Limitations. This measure, which displays 1/CEP of only the most accurate SLBM, disregards the accuracy of all other SLBMs in the force at that point in time. Since the most accurate SLBM is often the newest SLBM in the inventory, the curve is sensitive to the introduction of a new weapon system which would usually represent only a small portion of a nation's SLBM force in the year indicated by the measure.

The measure disregards all other measures of SLBM force effectiveness such as, prelaunch survivability, warhead yield, MIRV or MRV capability, hardness to nuclear effects, number of missiles, number of submarines on station, etc.

(U) Uncertainties. There is a degree of uncertainty associated with the accuracy and year of introduction of past and current Soviet missile systems. Future estimates are based upon a perception of the technological improvements in Soviet missile systems and have a greater degree of uncertainty.

(U) Comment. The accuracy of SLBMs can be improved by hardware or software changes to the missile and/or improvement in the accuracy of determining submarine position. These changes would be difficult to observe in the deployed forces.

AVERAGE ACCURACY OF THE ICBM FORCE (U)

(U) In order to utilize the standard graphic representation format of this report, the inverse of the average force accuracy has been plotted.

(U) Limitations. The measure, by simply averaging accuracy, takes no account of individual missile characteristics such as reliability, yield, and other factors of force effectiveness.

Any averaging of accuracies can be misleading without some idea of the distribution of these accuracies across the force.

(U) Uncertainties. While there is little uncertainty in the numbers and types of Soviet ICBMs, there is a great deal of uncertainty relative to the accuracies of Soviet missiles.

(U) Comment. Missile accuracy can be improved with hardware or software changes. In most cases, these improvements can be made undetected by the other side. They only become apparent through observation of missile tests which may or may not be a true indication of implementation. In addition, improved guidance observed in one missile type may or may not be incorporated in other missiles already deployed.

AVERAGE ACCURACY OF THE SLBM FORCE (U)

What it Measures. This measure compares the arithmetic means of the accuracies of the total US and USSR SLBM forces. (U)

(U) In order to utilize the standard graphic representation format of this report, the inverse of the average force accuracy has been plotted.

(U) Limitations. The measure takes no account of individual missile characteristics such as reliability, yield, and other factors of force effectiveness.

Any averaging of accuracies can be misleading without some idea of the distribution of accuracies across the force.

(U) Uncertainties. While there is little uncertainty in the numbers and types of Soviet SLBMs, there is a great deal of uncertainty relative to the accuracies of Soviet missiles.

(U) Comment. Not included in the measure is a comparison of the accuracy of determining submarine position. Launcher position is a key element in the total weapon delivery accuracy problem and is the main reason that SLBMs are not as accurate as contemporary ICBMs.

AVERAGE ACCURACY OF THE COMBINED ICBM AND SLBM FORCE (U)

What it Measures. This measure compares the arithmetic means of the accuracies of the total combined ICBM and SLBM force. (U)

(U) In order to utilize the standard graphic representation format of this report, the inverse of the average force accuracy has been plotted.

(U) The net effect of these biases, in 1986, results in an average missile force accuracy for both the US and USSR that is approximately equal despite the fact that the United States has the advantage in both average ICBM accuracy and average SLBM accuracy. The main point that must be considered is that averages which are only one measure of central tendency must be treated with caution.

(U) Comment. The comments applicable to the previous two measures are applicable to this measure. Combining the two measures ignores the fact that determining the accuracy of launcher position is a problem for SLBMs but not for ICBMs.

AVERAGE ACCURACY OF THE TOTAL STRATEGIC FORCE (ICBMS, SLBMS, AND BOMBERS) (U)

What it Measures. The reciprocal of the weighted average delivery accuracy, measured in nautical miles, of all the strategic nuclear weapons in each force is compared. (U)

(U) In order to utilize the standard graphic representation format of this report, the inverse of the average force accuracy has been plotted.

(U) Limitations. This measure, being a comparison of only the weighted average delivery accuracy of a force, disregards all other weapon characteristics such as yield, range, hardness to nuclear effects, etc.

This measure also does not consider numbers of delivery vehicles or characteristics such as alert rate, reaction time, survivability, etc.

(U) <u>Uncertainties</u>. There is a degree of uncertainty associated with the accuracy and year of introduction of Soviet strategic systems, particularly missile systems. Future estimates, which have a greater uncertainty, are based upon projections of Soviet technological improvements and force structure.

Page 138 was Deleted.

I. HARD TARGET KILL CAPABILITY. (U)

1. General. In this section, the hard target kill capability of the ICBM, SLBM, and bomber forces is compared. (U)

(U) Hard target kill capability is an aggregate measure employed as an indicator of relative counterforce capabilities. This measure is the result of an attempt to demonstrate the strategic balance in terms of the ability of a force to destroy hardened targets. A homogeneous target set is assumed which is at least as large as the number of warheads available. Target hardnesses of 1,000, 2,000, and 3,000 psi have been used to illustrate ICBM capabilities in this measure. (A hardness of 1,000 psi was used for SLBM, bomber, and total strategic force capability). This should not be construed as an indication of either US or USSR target set hardness in that these various hardnesses have been selected to demonstrate the effect of increasing hardness on this measure.

(U) A Vulnerability Number (VN) is used to indicate the relative resistance of a target to damage from blast pressure. The number itself has no physical significance. When assigned to a target, a VN identifies the relation believed to be held between the blast pressure and the probability of damage (of at least the specified degree) for a particular target. High VNs denote targets highly resistant to blast damage; low VNs denote targets with a low resistance to blast damage.

(U) A VN was assigned to each of the three example target sets based upon the hardness. Then, for each weapon system available, the Single Shot Probability of Kill (SSP_k) was determined for arriving weapons. This SSP_k was multiplied by the number of weapons of each type available each year in order to determine the total number of targets that could be destroyed in that year. Mathematically:

$$C = \text{Capability} = \sum_{i=1}^{\text{ICBM/SLBM}} R_i N_i P_{k_i}$$

where R_i = The reliability of the i^{th} system

N_i = the number of i^{th} independently targetable warheads available

P_{k_i} = the single shot probability of kill for the i^{th} independently targetable warhead.

(U) A combined force reliability rate of 0.85 was assumed in the calculations in this section.

2. (U) <u>General Limitations and Uncertainties</u>. Hard target kill capability, as a measure of counterforce capability, assumes that the number of targets is at least as great as the number of warheads; that all the targets have the same hardness, and that weapons (such as SLBMs) which are relatively ineffective against hard targets will be used against hard targets. The inaccuracies introduced do not necessarily cancel one another. Fratricide effects for warheads attacking nearby targets are not considered.

There are uncertainties associated with the yields, accuracies, and numbers of USSR warheads, and the quantities used are based on US estimates and projections.

3. Measures Considered in This Section:

ICBM Hard Target Kill Capability, 1,000 psi
ICBM Hard Target Kill Capability, 2,000 psi
ICBM Hard Target Kill Capability, 3,000 psi
SLBM Hard Target Kill Capability, 1,000 psi
ICBM and SLBM Hard Target Kill Capability, 1,000 psi
Bomber Hard Target Kill Capability, 1,000 psi
ICBM, SLBM, and Bomber Hard Target Kill Capability, 1,000 psi (U)

ICBM HARD TARGET KILL CAPABILITY, 1,000 PSI (U)

What it Measures. This measure compares the hard target kill capability of the two ICBM forces against targets with a hardness of 1,000 psi. This is equivalent to an adjusted VN of 37.3 (i.e., 1,000 psi) when considering a 1 MT weapon. (U)

Limitations. This is a general measure designed to illustrate the ability of a force to destroy a homogeneous target set. It is not intended to illustrate the ability of a force to destroy any specific target set. (U)

(U) The hardness of 1,000 psi was arbitrarily selected, and hence the measure cannot necessarily be used as a counterforce index.

(U) The measure assumes that there is a set of targets available which is at least as large as the number of independently targetable warheads available. This, of course, may or may not be the case.

(U) The measure fails to take into account other weapons systems characteristics which might have a significant impact upon the hard target kill capability of a force. For example, a combined launch and in-flight reliability of 0.85 was used in the calculations. While this value may be valid for general comparisons, ICBM launch, in-flight, and warhead reliabilities vary in actual practice. Also, not included in this measure is a consideration of possible fratricide or the synergistic effects of warheads being used against nearby targets.

(U) Uncertainties. The results of the calculations are based in part upon our conception of the composition of the Soviet ICBM force. There is little uncertainty associated with the numbers of Soviet ICBM launchers. There is a significant degree of uncertainty associated with the yield, accuracy, and number of independently targetable warheads associated with these ICBMs. For future years, the perceived Soviet ICBM force composition fits within the informal agreement reached at Vladivostok which provides a limit of 2,400 strategic nuclear delivery vehicles and limits MIRVed ballistic missile launchers to 1,320.

ICBM HARD TARGET KILL CAPABILITY, 2,000 PSI (U)

What it Measures. This measure is the same as the preceding measure except that a homogeneous target set of 2,000 psi was considered (i.e., an adjusted VN of 41.6 considering a 1 MT weapon). (U)

(U) Limitations. This measure has the same limitations as the preceding measure (ICBM Hard Target Kill Capability, 1,000 psi).

(U) Uncertainties. This measure has the same uncertainties as the preceding measure (ICBM Hard Target Kill Capability, 1,000 psi).

(U) Comment. The comment applicable to the preceding measure is also appropriate here. In addition, a comparison of the two measures indicates that doubling the hardness of the target set tends to bias the measure away from the generally higher yield, less accurate USSR ICBM force.

ICBM HARD TARGET KILL CAPABILITY, 3,000 PSI (U)

What it Measures. This measure is the same as the two preceding measures except that a homogeneous target set of 3,000 psi was considered (i.e., an adjusted VN of 43.3 considering a 1 MT weapon). (U)

(U) Limitations. This measure has the same limitations as the two preceding measures (ICBM Hard Target Kill Capability, 1,000 PSI and ICBM Hard Target Kill Capability, 2,000 PSI).

(U) Uncertainties. This measure has the same uncertainties as the two preceding measures (ICBM Hard Target Kill Capability, 1,000 PSI and ICBM Hard Target Kill Capability, 2,000 PSI).

Page 147 was Deleted

SLBM HARD TARGET KILL CAPABILITY, 1,000 PSI (U)

What it Measures. This measure compares the hard target kill capability of the two SLBM forces against targets with a hardness of 1,000 psi. This is equivalent to an adjusted VN of 37.3 (i.e., 1,000 psi) when considering a 1 MT weapon. (U)

(U) Limitations. This is a general measure designed to illustrate the ability of a force to destroy a homogeneous target set. It is not intended to illustrate the ability of a force to destroy any specific target set. The hardness of 1,000 psi was arbitrarily selected, hence the measure cannot necessarily be used as a counterforce index.

The measure assumes that there is a set of targets available which is at least as large as the number of independently targetable warheads available. This, of course, may or may not be the case.

The measure fails to take into account other weapons systems characteristics which might have a significant impact upon the hard target kill capability of a force. For example, a combined launch and in-flight reliability of 0.85 was used in the calculations. While this value may be valid for general comparisons, SLBM launch, in-flight, and warhead reliabilities vary in actual practice. Also, not included in this measure is a consideration of possible fratricide or the synergistic effects of warheads being used against nearby targets.

This measure addresses the SLBM inventory. Readiness rates will significantly affect the number of SLBMs on station and available.

(U) Uncertainties. The results of the calculations are based in part upon our perception of the Soviet SLBM force composition. There is a significant degree of uncertainty associated with the yield, accuracy, and number of independently targetable warheads of Soviet SLBMs. Since all of these are incorporated in the calculations, uncertainties in the values will result in corresponding uncertainties in the calculations. There is little uncertainty associated with the numbers of Soviet SLBM platforms (and hence the number of missiles) in the inventory for current and past years.

ICBM AND SLBM HARD TARGET KILL CAPABILITY, 1,000 PSI (U)

What it Measures. This measure is the summation of two previous measures, ICBM Hard Target Kill Capability, 1,000 PSI and SLBM Hard Target Kill Capability, 1,000 PSI. (U)

(U) Limitations. This measure has the same limitations as the two measures it totals (ICBM Hard Target Kill Capability, 1,000 PSI and SLBM Hard Target Kill Capability, 1,000 PSI).

(U) Uncertainties. This measure has the same uncertainties as the two measures it totals (ICBM Hard Target Kill Capability, 1,000 PSI and SLBM Hard Target Kill Capability, 1,000 PSI).

(U) Comment. The ballistic missile hard target kill capability of both nations is primarily a function of the ICBM force as SLBMs are generally not as accurate and have the added disadvantage of carrying smaller yields.

BOMBER HARD TARGET KILL CAPABILITY, 1,000 PSI (U)

What it Measures. This measure compares the hard target kill capability of the two bomber forces against targets with a hardness of 1,000 psi. This is equivalent to an adjusted VN of 37.3 (i.e., 1,000 psi) when considering a 1 MT weapon. (U)

(U) Limitations. This is a general measure designed to illustrate the ability of a force to destroy a homogeneous target set. It is not intended to illustrate the ability of a force to destroy any specific target set.

The measure assumes that there is a set of targets available which is at least as large as the number of independently targetable warheads available. This, of course, may or may not be the case.

Relatively ineffective weapons may have contributed significantly to the number of targets destroyed.

The measure fails to take into account other weapons systems characteristics which might have a significant impact upon the hard target kill capability of a force. For example, a combined weapon reliability and bomber penetrability of defenses of 0.85 was used in the calculations. While this may be valid for a general comparison, bomber penetrability and reliabilities vary in actual practice. Also not included in this measure is a consideration of possible fratricide or the synergistic effects of warheads being used against nearby targets.

Bomber loading was assumed to be the same as in previous measures of bomber weapon comparisons, that is maximum when weapon availability allowed.

(U) Uncertainties. The results of the calculations are based in part upon our perception of the composition of Soviet bomber forces. There is little uncertainty associated with the past and present numbers of Soviet bombers. There is a significant degree of uncertainty associated with the yield, accuracy, and number of independently targetable warheads associated with these bombers.

ICBM, SLBM, AND BOMBER HARD TARGET KILL CAPABILITY, 1,000 PSI (U)

What it Measures. This measure is the summation of three previous measures: ICBM Hard Target Kill Capability, 1,000 PSI; SLBM Hard Target Kill Capability, 1,000 PSI; and Bomber Hard Target Kill Capability, 1,000 PSI. (U)

(U) Limitations and Uncertainties. This measure, being the summation of three previous measures (i.e., ICBM Hard Target Kill Capability, 1,000 PSI; SLBM Hard Target Kill Capability, 1,000 PSI; and Bomber Hard Target Kill Capability, 1,000 PSI), incorporates all of the limitations and uncertainties of those three measures.

J. COUNTER MILITARY POTENTIAL. (U)

1. (U) General. This section compares the Counter Military Potential (CMP) of the US and USSR strategic nuclear forces. CMP, also called "lethality," is an aggregate measure of relative counterforce capabilities. Unlike Equivalent Megatons (EMT), which by aggregating the equivalent yield of each of a number of weapons suggests the total area which can be covered by a barrage, CMP assumes point target attacks. It is derived by dividing the equivalent yield by the square of the delivery accuracy (CEP^2), where CEP (circular error probable) is the radius of a circle around a point target within which half the weapons launched at it can be expected to strike. Mathematically this is expressed as:

$$CMP = \frac{EMT}{(CEP)^2}$$

where: $EMT = Y^{2/3}$

Y is measured in megatons

CEP is measured in nautical miles.

For example, a 100 KT warhead with a CEP of 0.25 nautical miles is valued as having a CMP of 3.44 and a 5 MT warhead with a CEP of 0.5 nautical miles is valued as having a CMP of 11.7 by this measure. It may be noted that the value of $Y^{2/3}$ has been used regardless of weapon yield when calculating EMT in order to determine CMP. In Section F, where target area was a consideration, various values were used for the exponent depending upon weapon yield.

2. (U) General Limitations and Uncertainties. Counter Military Potential (CMP) is a measure of a force's counterforce capability; it does not, however, take into consideration target hardness or weapon reliability. It should be noted that CMP approaches infinity as CEP approaches zero--i.e., as weapon accuracy improves. This factor becomes increasingly important as weapon systems achieve greater accuracies. All other individual weapon characteristics are not considered in this measure.

There are uncertainties associated with the yields, accuracies, and numbers of USSR warheads. The quantities used are based on US estimates and projections.

3. Measures Considered in This Section:

ICBM Counter Military Potential
SLBM Counter Military Potential
ICBM and SLBM Counter Military Potential
Bomber Counter Military Potential
ICBM, SLBM, and Bomber Counter Military Potential (U)

Page 157 was Deleted.

ICBM COUNTER MILITARY POTENTIAL (U)

What it Measures. This measure is the summation of the Counter Military Potential (CMP) of all the ICBMs in the force. (U)

Limitations. CMP is a measure intended to estimate a force's capabilities against hard point targets; however, it does not take into account the effects of target hardness. (U)

(U) The total values of Soviet CMP are based upon our perception of the type and number of ICBM launching sites. As a result, the possibility that some launchers may be capable of launching more than one missile is not included in the measure.

SLBM COUNTER MILITARY POTENTIAL (U)

What it Measures. This measure is the summation of the Counter Military Potential (CMP) of all the SLBMs in the force. (U)

Limitations. CMP is a measure intended to estimate a force's capability against hard point targets; however, it does not take into account the effects of target hardness. (U)

(U) The total values of Soviet CMP are based upon our perception of the type and number of observed ballistic missile submarines and thereby missiles.

(U) Uncertainties. There is a fair degree of uncertainty associated with the type and yield of the warheads on Soviet SLBMs as well as the accuracy of these systems. There is little uncertainty associated with the current and past numbers of Soviet SLBM launchers. Future estimates of SLBM launchers are based upon the assumption of a SAL agreement and may vary depending upon Soviet decisions and options therein.

A portion of the total number of submarines is undergoing overhaul and/or conversion at any given time, and therefore our estimate of which warheads may be associated with these submarines affects the total CMP calculation.

(U) Comment. SLBM counter military potential is presently limited by the comparative inaccuracy of these systems. SLBM CMP can also be increased with improvements in submarine position determination thereby improving SLBM accuracy.

ICBM AND SLBM COUNTER MILITARY POTENTIAL (U)

<u>What it Measures</u>. This measure totals the preceding two measures (ICBM Counter Military Potential and SLBM Counter Military Potential). It is, therefore, the summation of the CMP of all of the ICBMs and SLBMs in the force. (U)

(U) <u>Limitations and Uncertainties</u>. This measure, being the summation of the preceding two measures (i.e., ICBM Counter Military Potential and SLBM Counter Military Potential), incorporates all of the limitations and uncertainties of those two measures.

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BOMBER COUNTER MILITARY POTENTIAL (U)

What it Measures. This measure is the summation of the counter military potential of all warheads carried by the bomber force. (U)

(U) Limitations. CMP is a measure intended to estimate a force's capabilities against hard point targets. It is not intended to illustrate the ability of a force to destroy any specific target set.

Totaling up the CMP of bomber warheads does not take into consideration system or individual warhead effectiveness. Factors such as bomber penetrability, reliability, hardness to nuclear effects, etc., are not considered in this measure.

(U) Uncertainties. There is little uncertainty associated with current and past numbers of Soviet bombers. Future estimates are dependent on any SAL agreement and Soviet options within it.

There is a considerable degree of uncertainty associated with the type, yield, accuracy, and number of Soviet bomber-related warheads. All estimates are based upon US perceptions.

(U) Comment. Large deployments of the very accurate ALCM to the US bomber force following its introduction in the early 1980s are responsible for the large increase in CMP after 1981.

ICBM, SLBM, AND BOMBER COUNTER MILITARY POTENTIAL (U)

<u>What it Measures</u>. This measure totals three previous measures: ICBM Counter Military Potential, SLBM Counter Military Potential, and Bomber Counter Military Potential. (U)

(U) <u>Limitations and Uncertainties</u>. This measure, being the summation of three previous measures (i.e., ICBM Counter Military Potential, SLBM Counter Military Potential, and Bomber Counter Military Potential), incorporates all of the limitations and uncertainties of those three measures.

Additionally, the measure has the further limitation of considering all weapons, ICBMs, SLBMs, ASMs, and bombs, equally. It does not consider delivery vehicle characteristics.

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ICBM FIRST STRIKE. (U)

1. (U) General. This section addresses expected results of an ICBM first strike by either side against the other side's ICBM launchers. Such an exchange is, of course, not possible. However, this method has been utilized in order to present a comparison of US and USSR ICBM capability to draw down the other's force. The general methodology is as follows: Considering the launcher site of one side as a target, the probability of damage (P_d) is calculated when the other side's ICBMs are used as attacking weapons. The P_d is dependent upon ICBM launcher hardness and the attacking ICBMs yield and CEP. Using the precomputed P_d, calculations are then made for each year with one nation's ICBM force as the target and the other nation's ICBM force as the attacker. The calculations may be done in such a manner so as to optimize destruction of any one of the measures of an ICBM force (i.e., numbers of ICBM launchers, number of independently targetable ICBM warheads, ICBM gross yield, ICBM EMT, etc.). The two nations' roles are then reversed and a similar set of calculations are done.

In the case of the measures presented in this section, the following assumptions were used: Target/weapon combinations were selected to optimize the number of launchers destroyed. Two independently targetable warheads were targeted against launchers when the attacker's system characteristics and inventory permitted (i.e., in as far as was possible two-on-one cross-targeting was used). It was assumed that combined launch, in-flight, and strike reliability was 0.85 for both the United States and the Soviet Union. In those cases where a nation had sufficient weapons in inventory, reprogramming for unsuccessful launches was used. The effects of fratricide were not considered inasmuch as it was assumed that the timing problems of two-on-one cross-targeting could be resolved.

A comparison of a SLBM first strike was not made because of the general ineffectiveness of present SLBMs against hardened targets such as ICBM silos. Similarly, SLBMs or ICBMs were not considered for attacks on ballistic missile submarines, except for possible attacks against such submarines in port, due to problems associated with submarine detection.

Bombers were also not considered in a first strike role because of the time required from aircraft takeoff to the weapon release point. Present warning systems for both sides could detect such an attack early enough to allow the defending nation enough time to launch a retaliatory attack before the bombers arrived. ICBMs and SLBMs were also not targeted against bombers because of possible dispersion to multiple airfields and/or the fact that many bombers could be on airborne alert.

2. (U) Limitations and Uncertainties. The measure does not consider the numbers and types of weapons the attacking nation would have remaining after the first strike other than the total. It also does not depict the numbers and types the attacked nation would have remaining other than the total. The measure also excludes the effects of defensive or counter-offensive actions which may be taken such as ABMs, or attempts to launch out from under attack. Although, as discussed in earlier sections, there is some uncertainty associated with the yields, numbers of independently targetable warheads, accuracy, and reliability of Soviet ICBMs, there is greater uncertainty associated with the hardness of Soviet launchers. To a lesser degree, there is uncertainty regarding US ICBM launcher hardness.

Failing to consider ballistic missile submarines and intercontinental bombers as potential targets or as first-strike weapons systems is probably inconsistent with existing strategy. A concentrated effort could be made to locate and destroy these forces in conjunction with an ICBM first strike thereby limiting their role in any retaliatory role. Conversely, these forces, through planning, deployment and deception, could be used in a first strike role against other lesser non-hardened targets.

3. Measures Considered in This Section:

Surviving ICBM Launchers After a First Strike by Either the US or USSR
Surviving ICBM Warheads After a First Strike by Either the US or USSR
Residual ICBM Launchers after a First Strike by Either the US or USSR
Residual ICBM Warheads After a First Strike by Either the US or USSR

Average ICBM Silo Hardness
Average Warhead Yield in First Strike
Average Accuracy of Warheads in First Strike
Sensitivity of First Strike Analysis to Circular Error Probable
Sensitivity of First Strike Analysis to Yield
Sensitivity of First Strike Analysis to Target Hardness (U)

SURVIVING ICBM LAUNCHERS AFTER A FIRST STRIKE
BY EITHER THE US OR USSR (U)

What it Measures. This measure compares the results of an ICBM first strike by either side on the other side's ICBM launchers. (U)

(U) Limitations. To obtain the results of this measure, the number of ICBMs required may exceed the number of weapons which one nation is willing to expend in order to draw down another nation's ICBM force.

The measure does not depict the number and/or type of weapons that the attacking or attacked nation would have remaining in its inventory after the first strike.

The measure, by simply attempting to maximize the number of ICBM launchers destroyed, does not take into account the capabilities of the surviving ICBMs such as yield, EMT, numbers of independently targetable warheads, etc.

The measure disregards the possibility that the nation attacked may be able to launch out from under attack.

(U) Uncertainties. The P_d for each target is a function of the hardness of the target to nuclear effects and the yield and CEP of the offensive weapon; therefore, uncertainties in any of these three characteristics will effect the value of the P_d. Sensitivity of the calculations to these uncertainties are addressed later in this section.

There is a significant degree of uncertainty with regard to the hardness of Soviet ICBM launchers and to a lesser degree, the hardness of US ICBM launchers. There is some degree of uncertainty associated with the yields, numbers of independently targetable warheads, accuracy and reliability of Soviet launchers.

It was assumed that the weapon fratricide problems could be solved by timing of weapon arrival, hence the expected value disregards fratricide.

(3) (U) The attack calculations were done in a manner selected to optimize the number of launchers destroyed (i.e., minimize surviving launchers). Had some other criteria such as independently targetable warheads or gross yield been selected as the value which was to be optimized, a significant difference may have resulted.

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SURVIVING ICBM WARHEADS AFTER A FIRST STRIKE
BY EITHER THE US OR USSR (U)

What it Measures. This measure compares the number of independently targetable ICBM warheads that would survive a first strike by the US or USSR on the other side. (See Surviving ICBM Launchers After a First Strike by Either the US or USSR.) (U)

(U) Limitations. To obtain the results in this measure, the number of ICBMs required may exceed the number of weapons which one nation is willing to expend in order to draw down another nation's ICBM force.

The measure does not depict the number and/or type of weapons that the attacking nation would have remaining in its inventory after the first strike.

The measure disregards the possibility that the nation attacked may be able to launch out from under attack.

This measure is a result of the calculation for the previous measure (Surviving ICBM Launchers) in which an attempt is made to maximize the number of launchers destroyed and not the number of warheads destroyed.

(U) Uncertainties. There is some degree of uncertainty regarding the numbers and types of ICBM launchers surviving and hence the number of warheads surviving. Also, the number of Soviet warheads is not certain.

(U) Comment. The number of surviving ICBM warheads is dependent in large part upon the targeting philosophy employed. Had some other value such as independently targetable warheads or EMT been selected as the optimization criteria, significant differences in the expected value calculations may have resulted.

RESIDUAL ICBM LAUNCHERS AFTER A FIRST STRIKE
BY EITHER THE US OR USSR (U)

What it Measures. This measure compares the number of ICBM launchers remaining in a force's inventory after launching a first strike.

(U) Limitations. This measure is highly dependent upon the attack assumptions and targeting philosophy described in paragraph 1 of this section. The number of ICBMs that must be used in order to minimize the surviving ICBM launchers of the other side may exceed the number of ICBMs which either nation is willing to expend in a first strike.

This measure does not take into account the capabilities of the remaining ICBMs such as yield, EMT, number of independently targetable warheads, etc.

(U) Uncertainties. The number of surviving ICBM launchers depends upon the numbers and types of ICBMs expended in trying to draw down the opposing force. This in turn depends upon the attacker's targeting philosophy and upon individual weapon characteristics such as yield and accuracy. All of these are uncertain to one degree or another.

(U) Comment. While also a function of particular ICBM yields and accuracies, the numbers of residual launchers are in large part dictated by the targeting philosophy employed.

RESIDUAL ICBM WARHEADS AFTER A FIRST STRIKE
BY EITHER THE US OR USSR (U)

(U) Limitations. This measure is highly dependent upon the attack assumptions and targeting philosophy described in paragraph 1 of this section. The number of ICBMs that must be used in order to minimize the surviving ICBM launchers of the other side may exceed the number of ICBMs which either nation is willing to expend in a first strike.

This measure does not take into account the capabilities of the remaining ICBMs such as yield, EMT, CMP, etc.

(U) Uncertainties. The uncertainty of the previous measure, Residual ICBM Launchers After a First Strike by Either the US or USSR, is applicable to this measure. Additionally, there is some uncertainty relative to the numbers of MIRVs or Soviet ICBMs.

(U) Comment. While also a function of particular ICBM yields and accuracies, the number of residual warheads, like launchers, is in large part dictated by the targeting philosophy employed.

AVERAGE ICBM SILO HARDNESS (U)

(U) Limitations. Average silo hardness gives only a rough idea of the survivability of an ICBM force to attack. Survivability is intimately related to the opposing force's yields, accuracies, and numbers.

(U) Uncertainties. Since silo hardness is related to many factors of construction (i.e., type of concrete, reinforcing rods, shape, etc.), and site geology, the hardnesses used were only approximations.

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(U) Limitations. The measure, by simply averaging yield, excludes additional individual missile characteristics such as reliability, accuracy, and other factors of counter-force effectiveness.

The measure does not consider the effectiveness of the remaining force; i.e., the force remaining after a first strike.

There are many different targeting combinations possible and it is unlikely that the particular combination of warheads used in the simulated attack would actually be used.

(U) Uncertainties. There is little uncertainty in the numbers and types of Soviet ICBMs. However, the yields and the accuracies of the missiles used are estimates based upon US perceptions. These characteristics, in part, dictated which missiles were used in the attacks.

(U) Comment. The warheads used in the first strike were dictated more by warhead accuracy than yield. For instance, while the Soviet Union maintains a large arsenal of high yield weapons, it was more advantageous in the counterforce strikes of later years to use the lower yield warheads with the greater accuracies.

AVERAGE ACCURACY OF WARHEADS USED IN FIRST STRIKE (U)

(U) In order to utilize the standard graphic representation format of this report, the inverse of the average accuracy has been plotted.

(U) Limitations. The measure, by simply averaging accuracies, takes no account of the other individual missile characteristics such as reliability, yield, and other factors of counterforce effectiveness.

The measure ignores the effectiveness of the remaining force; i.e., the force remaining after attacking.

There are many possible targeting combinations and therefore it is unlikely that the particular combination of warheads used in the simulated attack would actually be used.

(U) Uncertainties. There is little uncertainty in the number of and type of Soviet ICBMs. However, there is a greater degree of uncertainty relative to the accuracies of these ICBMs which are estimates based upon US perceptions.

(U) Comment. The accuracies of the available warheads were in large part the main factors in warhead selection for the initial strikes.

SENSITIVITY OF FIRST STRIKE ANALYSIS TO
CIRCULAR ERROR PROBABLE (U)

What it Measures. Figure II-53 (Surviving ICBM Launchers After a First Strike by Either the US or USSR), represents a comparison of the expected results of an ICBM first strike by either side against the other side's ICBM launchers. In the discussion of that measure it was noted that the probability of damage (P_d) for each target is a function of both the hardness of the target to nuclear weapon effects and the yield and CEP of the offensive weapon. This measure is designed to illustrate the sensitivity of Figure II-53 to offensive weapon CEP data inaccuracies. This was done by recalculating the results for the year 1978 with all factors except weapon CEP held constant. Weapon CEP was changed in ten percent increments, and the number of surviving ICBM launchers surviving a first strike by either the US or USSR was recalculated for each of these increments. (U)

(U) Limitations. The surviving ICBM launcher results shown in Figure II-60 were obtained using the same targeting strategy as originally applied. While a different targeting strategy might produce different absolute values, the relative values that result from changes in CEP would be similar to those shown.

Since this measure analyzes only the effects of changing CEP on the number of surviving ICBMs, other factors which could also affect the results such as changes in yield, system reliability, silo hardness etc., were not considered. Collectively, these factors might compound to produce greater changes than any single factor taken by itself.

(U) Uncertainties. There is a large degree of uncertainty associated with the actual CEP of US and Soviet ICBMs due to the limited number of missile tests from which data were obtained. In the case of Soviet ICBMs, CEP estimates are based upon intelligence sources. Additional factors contributing to accuracy uncertainties are errors concerning launcher and target positions, the gravitational field of the earth, and the guidance system hardware within the missile itself. A discussion of these factors is contained in Appendix C.

(U) Comment. A comparison of sensitivity analyses for CEP, yield, and silo hardness indicates that the number of surviving ICBMs is most sensitive to changes in CEP.

SENSITIVITY OF FIRST STRIKE ANALYSIS TO YIELD (U)

<u>What it Measures</u>. This measure is similar to Sensitivity of First Strike Analysis to Circular Error Probable (Figure II-60), except that the sensitivity of first strike analysis to weapon yield was examined. (U)

(U) <u>Limitations</u>. The surviving ICBM launcher results shown in Figure II-61 were obtained using the same targeting strategy as the original 1978 analysis. While a different targeting strategy might produce different absolute values, the relative values that result from changes in yield will be similar to those shown.

Since the measure analyzes only the effects of changing the yield on the number of surviving ICBM launchers, other factors which could also affect the results such as changes in CEP, system reliability, etc. were not considered.

Collectively, these factors would combine to produce greater changes than any single factor taken by itself.

The given yields for the US and USSR missiles are based upon estimates of yield at the time the individual missile was developed. After a missile remains in a silo over a period of time, however, the nuclear material may partially decay so that actual missile yield will be less than originally expected.

Since this measure analyzes only the sensitivities of surviving launchers with respect to changes in yield, other factors which could effect the results such as changes in missile CEP and silo hardness were not included.

(U) Uncertainties. The uncertainties in the number of surviving launchers with respect to the base number in 1978 are small. The absolute number of surviving launchers due to changes in missile yield, however, possess the same uncertainties as the base 1978 result.

SENSITIVITY OF FIRST STRIKE ANALYSIS TO TARGET HARDNESS (U)

What it Measures. This measure is similar to Sensitivity of First Strike Analysis to Circular Error Probable (Figure II-60), except that the sensitivity of first strike analysis to target hardness was examined. (U)

(U) Limitations. The surviving ICBM launcher results shown in Figure II-62 were obtained by using the same targeting strategy as the original 1978 analysis. While a different targeting strategy might produce different absolute values, the relative values that result from changes in silo hardness will be similar to those given.

The given hardnesses for the US and USSR silos are based upon estimates of the characteristics of the silo construction. There are many factors which can affect silo hardness. Among these are the geological characteristics surrounding the silo site such as quantity and type of rock, as well as the moisture contained in the soil.

Since this measure analyzes only the effects of varying silo hardnesses on the number of surviving launchers, other factors which could influence the results, such as weapon system reliability, yield, and CEP were not considered. The sensitivities of missile yields and CEPs were discussed previously in this section.

(U) Uncertainties. The uncertainties in the number of surviving launchers with respect to the base numbers in 1978 are small. The absolute number of surviving launchers due to changes in silo hardness, however, possess the same uncertainties as the base 1978 result.

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E. RETALIATORY EQUIVALENT WEAPONS. (U)

1. (U) General. The measures in this section are an attempt to demonstrate the strategic balance in terms of the capability of a force to retaliate after sustaining a counterforce first strike.[8] This section only addresses the second strike effectiveness against a specific enemy target structure.

For each weapon system considered, the effectiveness against a generalized target structure is determined. This effectiveness is defined as "equivalent weapons" (EW).

$$EW \text{ (per weapon)} = \frac{1}{\frac{a}{P_{k_1}} + \frac{b}{P_{k_2}} + \frac{c}{P_{k_3}}}$$

Where a, b, and c are different types of targets, each expressed as a ratio relative to the total number of targets in the target structure, P_k is the expected probability of kill against that type of target. In this section only three types of targets are considered (a--soft point targets, b--soft area targets, and c--hard point targets--(i.e., 1,000 psi has been used in this measure)). Thus,

$a + b + c = 1$,

P_{k_1} = 1 soft point target can be killed by any weapon used.

$P_{k_2} = \frac{Y}{Y_0}^{2/3} = Y^{2/3}$ when Y_0 = 1 MT, $Y^{2/3}$ gives the P_k (expected value) against the area destroyed by a 1 MT weapon. Therefore, for a soft target, the area of damage due to blast overpressure is proportional to the two-thirds power of a weapon's yield. This results in multi-megaton yield weapons, which are capable of killing larger areas than a 1 MT weapon, being assigned an artificial "P_k" greater than 1, although it is recognized that a probability cannot exceed 1.

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[8] Fred A. Payne, "The Strategic Nuclear Balance: A New Measure," Survival, Volume XX, Number 3, May/June 1977.

P_{K_3} = The single shot probability of kill for an independently targetable warhead against a homogeneous target set with an adjusted vulnerability number (VN) of 37.3 (i.e., 1,000 psi hard) when considering a 1 MT weapon.

2. (U) General Limitations and Uncertainties. There are three difficulties in the formulation of Retaliatory Equivalent Weapons:

a. The probability of kill of a soft area target is not the EMT of the weapon used against it. EMT is not a probability of any kind.

b. The target structure is in fact assumed to be infinite; moreover, it is assumed to be the same for both sides.

c. The measure allocates weapons to targets proportionally to pre-attack strategy.

The net result of a and b is that Retaliatory EW overestimates the number of targets that can be destroyed by standard expected value calculations. The result of c is to induce a bias in the measure which favors a homogeneous force relative to a force consisting of weapons with diverse characteristics. Therefore, because of the homogeneity of the US force as compared to the Soviet force, Retaliatory EW tends to overestimate US capabilities relative to USSR capabilities.

There is a degree of uncertainty in the number of surviving ICBM and bomber forces, and to a lesser degree, surviving SLBMs. There is also uncertainty in the yields, accuracies, and number of USSR warheads.

For a target set composed primarily of soft point targets, the EW (per weapon) approaches unity. For a target set composed primarily of soft area targets, the EW (per weapon) approaches the EMT of the weapon. Finally, for the target set composed of hard point targets, the EW (per weapon) approaches the single shot probability of kill for that weapon against a hard point target.

Therefore, a target structure can be chosen which will optimize the EW of one force to the detriment of the other.

3. (U) Measures Considered in This Section:

Reliable ICBM Retaliatory Equivalent Weapons, Case I
Reliable ICBM Retaliatory Equivalent Weapons, Case II
Reliable ICBM Retaliatory Equivalent Weapons, Case III
Reliable SLBM Retaliatory Equivalent Weapons

Reliable ICBM and SLBM Retaliatory Equivalent Weapons
Reliable Bomber Retaliatory Equivalent Weapons
Reliable ICBM, SLBM, and Bomber Retaliatory Equivalent Weapons

4. <u>ICBM Retaliatory Equivalent Weapons</u>. A comparison of the equivalent weapons in the two forces can be made but a more appropriate comparison is the total EW either side could deliver on the other after sustaining a direct counterforce strike. This total, for ICBMs only, is represented by the following:

$$\text{ICBM Retaliatory EW} = \sum_{i=1}^{\text{ICBM}} N_i EW_i \rho Ps^{BM\ ATK} Pp^{ABM}$$

where N_i = number of i^{th} weapons (independently targetable RVs)

EW_i = equivalent weapons of the i^{th} system

ρ = weapon reliability and other deficiencies

$Ps^{BM\ ATK}$ = probability of surviving a ballistic missile attack

Pp^{ABM} = probability of penetrating an anti-ballistic missile attack. (U)

(U) To examine the effect the target structure would have on the results, three cases were compared with the target structure ratio varied as follows:

Case I : a = 0.4, b = 0.4, c = 0.2

Case II : a = 0.4, b = 0.2, c = 0.4

Case III : a = 0.2, b = 0.4, c = 0.4

(U) The first three measures in this section address reliable ICBM retaliatory equivalent weapons for the three different target structure ratios. In these measures, for illustrative purposes, the results of the previous measure "Surviving ICBM Launchers After a First Strike by Either the US or USSR" were used to determine the number (N_i) of weapons available to either side for a retaliatory strike. Having survived a first strike, the term $Ps^{BM\ ATK}$ = 1 for these weapons. The EW_i per weapon was calculated as indicated above, with ρ assumed to be 0.85 and Pp^{ABM} equal to 1. The re-

fore, under the above assumptions, the calculations of the total reliable ICBM retaliatory EW becomes the summation of the EW (per weapon) times the number of surviving weapons of each type in the force times the reliability. Mathematically:

$$\text{ICBM Retaliatory EW} = \sum_{i=1}^{\text{ICBM}} 0.85\, N_i EW_i$$

where N_i = the number of surviving i^{th} system warheads

EW_i = the equivalent weapons of the i^{th} system

0.85 = the combined force reliability rate assumed in the calculations.

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RELIABLE ICBM RETALIATORY EQUIVALENT WEAPONS, CASE I (U)

What it Measures. This measure compares US and USSR reliable ICBM retaliatory equivalent weapons against a target structure composed of soft point targets, soft area targets, and 1,000 psi hard point targets. The ratio of these targets for this case was assumed to be:

a (soft point targets) = 0.4
b (soft area targets) = 0.4
c (1,000 psi hard point targets) = 0.2 (U)

(U) Limitations. This is a general measure designed to illustrate the ability of a force to retaliate after sustaining a counterforce strike. The available weapons used in the calculations were the result of a previous measure and may or may not represent the actual situation which might exist.

The measure assumes that there is a set of targets available which is at least as large as the number of retaliatory equivalent weapons available. This, of course, may or may not be the case.

The measure addresses a total target structure composed of soft point targets, soft area targets and hard point targets (1,000 psi) and proportionally aligned in the ratios stated in the example used. Actual target structure may vary significantly, and, depending upon targeting philosophy, available weapons, and weapon characteristics, so will targets destroyed.

The measure fails to take into account other weapon system characteristics which might have a significant impact upon the hard target kill capability of a force. For example, a combined launch and in-flight reliability of 0.85 was used in the calculations. While this value may be valid for general comparisons, ICBM launch, in-flight, and warhead reliabilities vary in actual practice. Also not included in this measure is a consideration of possible fratricide in the case where two or more RVs are used against a single target or the synergistic effects of warheads being used against nearby targets.

(U) Uncertainties. The results of the calculations are based in part upon our conception of the composition of the Soviet ICBM force. There is little uncertainty associated with the numbers of Soviet ICBM boosters used in the measure "Surviving ICBM Launchers After a First Strike by Either the US or USSR" to determine the weapons available for this measure. There is a significant degree of uncertainty associated with the yield, accuracy, and number of independently targetable warheads associated with these ICBMs and with the number and type of either US or USSR ICBMs that would actually survive a first strike. In addition, the target structure and use of the surviving weapons by either side may vary significantly from those used in this measure.

(U) Comment. When a target structure is composed primarily of soft point targets and soft area targets, the measure will be biased towards the Soviet ICBM force with its large yield, relatively inaccurate weapons (as compared to contemporary US weapons).

RELIABLE ICBM RETALIATORY EQUIVALENT WEAPONS, CASE II (U)

What it Measures. This measure is the same as the preceding measure except that the target ratio has been changed. Specifically:

a (soft point targets) = 0.4

b (soft area targets) = 0.2

c (1,000 psi hard point targets) = 0.4 (U)

(U) Limitations and Uncertainties. The limitations and uncertainties for Case I apply to Case II.

(U) Comment. The Case II target structure places a greater emphasis on hard point targets than in Case I. This introduces a bias in favor of the more accurate ICBM force, which in this case is the US force.

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RELIABLE ICBM RETALIATORY EQUIVALENT WEAPONS, CASE III (U)

What it Measures. This measure is the same as the preceding two measures except that the target ratio has been changed. Specifically:

a (soft point targets) = 0.2

b (soft area targets) = 0.4

c (1,000 psi hard point targets) = 0.4 (U)

(U) Limitations and Uncertainties. The limitations and uncertainties for Cases I and II also apply here.

(U) Comment. The equal emphasis on soft area targets and hard point targets in the target structure negates some of the differences in the US and USSR ICBM warheads. However, an inherent bias remains in the measure since

retaliatory equivalent weapons favors a more homogeneous force over a heterogeneous one (i.e., the measure tends to favor the US ICBM force over the USSR ICBM force).

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5. <u>SLBM Retaliatory Equivalent Weapons</u>. Paragraph 4 of this section addressed ICBM retaliatory equivalent weapons. The following measure is the same as the preceding measures except that only SLBMs are addressed. A target structure similar to the ICBM Case I was assumed. The total reliable SLBM retaliatory equivalent weapons is represented by the following:

$$\text{SLBM Retaliatory EW} = \sum_{j=1}^{\text{SLBM at sea}} N_j EW_j \rho Ps^{ASW} Ps^{ABM}$$

where N_j = number of j^{th} weapons (independently targetable RVs)

EW_j = equivalent weapons of the j^{th} system

ρ = weapon reliability and other deficiencies

Ps^{ASW} = probability of surviving an anti-submarine warfare (ASW) attack

Ps^{ABM} = probability of penetrating an anti-ballistic missile (ABM) system. (U)

(U) One-half of the ballistic missile submarines (and therefore approximately one-half of the total independently targetable SLBM RVs) were assumed to be on station and available to either side for a retaliatory strike. The EW_j per weapon is calculated as in the previous measure. Ps^{ASW} was assumed to be equal to 1, ρ was assumed to be 0.85, and Ps^{ABM} was assumed to be 1. Therefore, under the above assumptions, the calculations of the total reliable SLBM retaliatory EW becomes one-half of the summation of the EW_j (per weapon) times the number of available weapons of each type in the force times the reliability. Mathematically:

$$\text{SLBM Retaliatory EW} = 0.5 \sum_{j=1}^{\text{SLBM}} 0.85\, N_j EW_j$$

where N_j = the number of j^{th} system warheads

EW_j = the equivalent weapons of the j^{th} system

0.85 = the combined force reliability rate assumed in the calculations

RELIABLE SLBM RETALIATORY EQUIVALENT WEAPONS (U)

What it Measures. This measure compares US and USSR reliable SLBM retaliatory equivalent weapons using the same Case I target structure assumed for the preceding ICBM comparison. Specifically:

a (soft point targets) = 0.4

b (soft area targets) = 0.4

c (1,000 psi hard point targets) = 0.2 (U)

(U) Limitations. This measure has the same limitations as the previous Case I ICBM measure (Reliable ICBM Retaliatory Equivalent Weapons, Case I).

Additionally, the actual numbers of submarines on station may vary considerably from the 50 percent assumed in the calculations, and the probability of surviving an ASW attack may be significantly less depending upon any determined efforts to locate the submarines and destroy them in conjunction with the first strike on the homeland of the submarines.

(U) Uncertainties. The results of the calculations are based in part upon our perception of the composition of the Soviet SLBM force. There is a significant degree of uncertainty associated with the yield, accuracy, and number of independently targetable warheads associated with Soviet ICBMs. There is little uncertainty associated with the number of Soviet SLBM platforms (and hence number of missiles) in the inventory for current and past years. Future estimates are based upon the assumption of a SAL agreement and may vary considerably depending upon Soviet decisions relative to options contained in the agreement. In addition, the target structure and use of the available weapons by either side may vary significantly from those used in this measure.

(U) Comment. The low yield, relatively inaccurate SLBMs have little effectiveness against hard point targets. Rather than allocate them across the target structure in accordance with the definition of EW in actual practice these weapons would probably be allocated against soft point and soft area targets and ICBMs would be allocated against hard point targets.

RELIABLE ICBM AND SLBM RETALIATORY EQUIVALENT WEAPONS (U)

What it Measures. This measure is the total of two previous measures (Reliable ICBM Retaliatory Equivalent Weapons, Case I; and Reliable SLBM Retaliatory Equivalent Weapons). (U)

(U) Limitations and Uncertainties. This measure, being the summation of two other measures (i.e., Reliable ICBM Retaliatory Equivalent Weapons, Case I; and Reliable SLBM Retaliatory Equivalent Weapons), incorporates all of the limitations and uncertainties of those two measures.

(U) Comment. The comments applicable to the two measures which are summed for this measure (i.e., Reliable ICBM Retaliatory Equivalent Weapons, Case I; and Reliable SLBM Retaliatory Equivalent Weapons) are appropriate here.

6. <u>Bomber Retaliatory Equivalent Weapons</u>. The following measure is similar to the preceding ones in this section except that only bomber forces are addressed. The total reliable bomber retaliatory equivalent weapons is represented by the following:

$$\text{Bomber Retaliatory EW} = \sum_{k=1}^{\text{Bombers}} N_k \; EW_k \; \rho \; Ps^{BM\ ATK} Ps^{PEN}$$

where N_k = number of k^{th} weapons

EW_k = equivalent weapons of the k^{th} system

ρ = weapon reliability and other deficiencies

$Ps^{BM\ ATK}$ = probability of surviving a ballistic missile attack

Ps^{PEN} = probability of bomber penetration. (U)

(U) For bombers in this section, a combined probability of penetration and reliability of 0.85 was used, and it is assumed that 0.33 of the bombers will survive a ballistic missile attack for illustrative purposes. The EW_k per weapon is calculated as before.

Thus, mathematically:

$$\text{Bomber Retaliatory EW} = \sum_{k=1}^{\text{Bomber}} (0.33)(0.8\text{:} \quad N_k \; EW_k$$

where N_k = the number of k^{th} system warheads

EW_k = the equivalent weapons of the k^{th} system.

RELIABLE BOMBER RETALIATORY EQUIVALENT WEAPONS (U)

What it Measures. This measure compares US and USSR reliable bomber retaliatory equivalent weapons using the same target structure as in the ICBM Case I measure. Specifically:

a (soft point targets) = 0.4

b (soft area targets) = 0.4

c (1,000 psi hard point targets) = 0.2 (U)

(U) Limitations. This measure has the same limitations as the previous Case I, ICBM measure (Reliable ICBM Retaliatory Equivalent Weapons, Case I). Additionally, the combined reliability and penetrability of bombers may be much less than the assumed 0.85. Similarly, the probability of bomber survival from a ballistic missile attack may be much different than the 0.33 which was assumed.

(U) Uncertainties. The results of the calculation are based in part upon our perception of the composition of the Soviet bomber force. There is a fair degree of uncertainty associated with the yield, accuracy, and numbers of Soviet bomber warheads. There is little uncertainty regarding numbers of past and present Soviet bombers. Estimates of future numbers are less certain.

(U) Comment. The emphasis on soft area over hard points induces a bias toward the larger yield Soviet bomber weapons and away from the more accurate lower yield US ALCMs which are deployed by the US after 1980.

RELIABLE ICBM, SLBM AND BOMBER
RETALIATORY EQUIVALENT WEAPONS (U)

What it Measures. This measure is the total of three previous measures: Reliable ICBM Retaliatory Equivalent Weapons, Case I; Reliable SLBM Retaliatory Equivalent Weapons; and Reliable Bomber Retaliatory Equivalent Weapons. (U)

(U) Limitations and Uncertainties. This measure, being the summation of three previous measures (i.e., Reliable ICBM Retaliatory Equivalent Weapons, Case I; Reliable SLBM Retaliatory Equivalent Weapons; and Reliable Bomber Retaliatory Equivalent Weapons), incorporates all of the limitations and uncertainties of those three measures.

(U) Comment. The comments applicable to the previous three measures which have been summed to produce this one (i.e., Reliable ICBM Retaliatory Equivalent Weapons, Reliable SLBM Retaliatory Equivalent Weapons, and Reliable Bomber Retaliatory Equivalent Weapons) are appropriate here.

Additionally, a comparison of the three individual measures with this total, indicates that US ICBMs and bombers accounted for the greatest part of the Retaliatory Equivalent Weapons in the early years, while in the later years SLBMs and bombers provide the largest share. This is due to the greater number of US ICBMs surviving the first strike combined with the greater numbers of bombers in the early years and, in later years, the increased number of SLBM reentry vehicles as well as the addition of the ALCM to the bomber force. The dominant factor in total Soviet Retaliatory Equivalent Weapons is always ICBMs.

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M. STRATEGIC DEFENSIVE SYSTEMS. (U)

1. General. This section compares the numbers of strategic defensive weapons of the US and USSR. It does not address passive defensive measures. (U)

(U) The relationships between offensive and defensive systems, when addressing the strategic balance, are not linear. Defenses may be active and include interceptor aircraft, Surface-to-Air Missiles (SAMs), and ASW forces. They may be passive and include dispersal of the targetable resources, population sheltering, and hardening of specific sites. Whether active or passive, a small increase in defensive posture of one nation might require a major increase in the offensive capability of the other nation to maintain the balance. On the other hand, a large effort to improve defenses might be required as a result of a relatively small increase in the offensive capability of the other nation.

(U) A comprehensive analysis of the strategic balance must consider defensive systems. While these systems cannot directly threaten the homeland of the other nation, they can contribute to strategic stability or instability.

a. Anti-Ballistic Missile Forces. The Anti-Ballistic Missile (ABM) systems of the two countries are constrained by the ABM Treaty of 1972. This treaty limited both the US and USSR to two ABM sites each. One site could be located to protect the national capital and the other to protect an ICBM launch area. Each site was further limited to 100 launchers and missiles. Additional restrictions were placed on the number and types of radars which could be employed at the sites. (U)

(U) A protocol to the ABM Treaty ratified on November 10, 1975, subsequently limited the parties to only one ABM deployment site. This site may be relocated on a one-time basis with advance notice given of the change.

(U) The Soviet ABM defenses are centered around Moscow and include early warning radars, battle management radars, and engagement radars in addition to four interceptor missile launch complexes. Each lauch complex contains 16 launchers for the ABM-1 GALOSH missile for a total of 64 launchers.

(U) The US Ballistic Missile Defense (BMD) system, SAFEGUARD, located at Grand Forks, North Dakota, consisted of the necessary radars and 100 launchers for 30 SPARTAN and 70 SPRINT interceptor missiles. It was terminated and inactivated at the direction of Congress after only one year of operation.

The actual numbers of ABM launchers do not present a meaningful graph to show the trends of the defensive system available to either nation; rather, a comparison is made in the following table: (U)

ABM LAUNCHERS (U)

b. (U) Anti-Submarine Warfare Forces. Anti-Submarine Warfare (ASW) capabilities are important considerations in assessing the effectiveness of the SLBM forces. Both the US and USSR are confronted with the fact that nearly three-fourths of the surface of the earth is covered by the oceans. The total land area of the US and USSR is equal to only about ten percent of this ocean area. If only ten percent of the ocean area is available and useful for ballistic missile submarines (the area determined by the range of the SLBMs carried by the submarines), then the problem of detection and tracking even 100 submarines is immense. As a result, both nations have supported substantial research and development programs directed toward solving the various ASW problems. The complexities of the problem and the various types of resources used in ASW preclude a comparison of US and USSR capabilities in this document.

c. (U) Air Defense Forces. The most extensive strategic air defense system in the world is maintained by the USSR, and consists of more than 12,000 Surface-to-Air Missile (SAM) launchers, about 3,000 inter-

ceptor aircraft, and over 6,000 radars located at early warning and ground control intercept (EW/GCI) radar sites. This sizable force was generated to counter the large numbers of US bombers. The number of interceptors assigned to the PVO Strany (the Soviet Air Defense Force) reached a peak of about 4,000 in the mid-1960s. It decreased at a slow but steady rate to 2,600 in 1976, due to the retirement of older, clear-weather-only fighters at a faster rate than the introduction of more advanced aircraft armed with air-to-air missiles and an all-weather capability. The deployment of these newer fighters has continued to increase, and the total force is expected to reach about 3,100 aircraft by 1986.

About one-third of the present force consists of pre-1964 aircraft (MIG-17 FRESCO-D, MIG-19 FARMER-B/E, and SU-9 FISHPOT-B). The remaining two-thirds are newer generation interceptors (YAK-28P FIREBAR, SU-11 FISHPOT-C, TU-128 FIDDLER, SU-15 FLAGON-A/D/E, MIG-25 FOXBAT-A, and MIG-23 FLOGGER), with the MIG-23, SU-15, and MIG-25 fighters presently being deployed to PVO Strany units.

The Soviet strategic SAM forces, which show a steady expansion and improvement, are composed of four systems. These systems are the SA-1 GUILD, the SA-2 GUIDELINE, the SA-3 GOA, and the SA-5 GAMMON. The number of older SA-1 and SA-2 systems are gradually decreasing as the deployment of the SA-3 and SA-5 systems increases.

The US air defense system is considerably smaller than that of the USSR. Some of this difference can be attributed to the Soviet reliance on ICBM and SLBM nuclear weapons delivery vice manned bombers and some of it due to decisions based upon tight budget constraints.

The only active US Air Force interceptor dedicated to air defense is the F-106 DELTA DART which entered service in 1956. In 1976 there were 114 of these fighters assigned to regular active squadrons, with the US Air National Guard providing an additional 243 aircraft to air defense which were 90 F-106, 19 F-102 DELTA DAGGER, and 134 F-101 VOODOO aircraft.

General purpose forces from the Air Force Tactical Air Command (TAC), and from Army, Navy, and Marine forces which have primary missions

other than strategic air defense could be used to augment the above forces. The primary general purpose fighter used to augment the interceptor force would be the F-4 PHANTOM II. Additionally, as F-14 TOMCAT and F-15 EAGLE fighters become more numerous, these highly sophisticated and capable aircraft will also be available.

By 1975, all US strategic SAM forces had been inactivated. However, three general purpose force SAM battalions are retained in Florida and one in Alaska in a strategic role. These forces are armed with NIKE-HERCULES SAMs and complement the interceptor aircraft in these two locations.

2. (U) General Limitations and Uncertainties. The measures in this section only indicate numbers of SAMs and strategic interceptor aircraft. They do not consider individual weapon system characteristics such as range, altitude capability, guidance and control, etc. Offensive system countermeasures which may be employed against these defensive weapons are also disregarded. Offensive strategy which accounts for defensive systems by targeting them, evading them, or using weapons against which they may have little effect in their defensive areas may negate much of their capability. There is some uncertainty associated with the current and past numbers of Soviet defensive weapons, and a greater degree of uncertainty associated with our perception of future forces. There is also uncertainty relative to the command and control, warning, deployment, and employment of the defensive forces.

3. Measures Considered in This Section:

Strategic Surface-to-Air Missile Launchers
Strategic Air Defense Interceptor Aircraft (U)

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STRATEGIC AIR DEFENSE INTERCEPTOR AIRCRAFT (U)

What it Measures. The number of aircraft assigned to a strategic defensive role is totaled. The active US Air Force and the combined US Air Force and Air National Guard forces are both depicted. The Soviet aircraft are interceptor aircraft assigned to the PVO Strany (the Soviet Air Defense Force). (U)

(U) Limitations. This measure, by counting the number of strategic defensive interceptor aircraft, disregards the number of aircraft actually available to fly missions. It also does not consider aircraft base locations.

This measure does not include interceptor force capabilities such as range, fire-control systems, weapons, speed, and altitude.

This measure does not include similar aircraft assigned to US tactical and naval units and the Soviet Frontal Aviation units. Both the United States and the Soviet Union have a significant number of aircraft capable of fulfilling an interceptor role but which are assigned to tactical missions.

This measure disregards any defensive measures which may be employed by the offensive forces.

(U) Uncertainties. There is some uncertainty associated with the number of current and past Soviet strategic defensive interceptor aircraft. There is a greater degree of uncertainty associated with our perception of future Soviet interceptor forces.

(U) Comment. The large number of Soviet interceptors is in part dictated by the large US strategic bomber force, while the inverse is true for the numbers of US interceptors. Large numbers of Soviet interceptors also provide in-depth protection against potential tactical assaults around the periphery of the Soviet Union.

STRATEGIC SURFACE-TO-AIR MISSILE LAUNCHERS (U)

What it Measures. This measure totals the number of strategic Surface-to-Air Missile (SAM) system launcher arms/rails. The US figures are for the number of NIKE HERCULES and BOMARC, while the USSR figures total the number of SA-1, SA-2, SA-3, and SA-5 launcher rails. (U)

(U) Limitations. This measure, by totaling the number of launcher rails disregards the number of systems actually available for a defensive role. Either positioning (locations) or system status may prevent any defensive use.

This measure does not include SAM characteristics such as range, altitude capability, guidance, etc.

This measure, by counting launcher rails, disregards any reload capabilities.

This measure also disregards any defensive measures employed by the offensive forces.

(U) Uncertainties. There is some uncertainty associated with the current and past numbers of Soviet SAM launchers. There is a greater degree of uncertainty associated with our perception of future Soviet SAM forces.

(U) Comment. As in the case of strategic air defense interceptor aircraft, the large number of US strategic bombers urged the development and deployment of a massive network of SAMs by the Soviet Union. Various countermeasures by the offensive forces may tend to lower any purely numeric advantage.

WARHEAD YIELD-TO-WEIGHT CAPABILITY (U)

1. (U) General. Reduction of warhead weight without a corresponding loss in weapon yield was an early consideration in nuclear weapon design and fabrication. This consideration became more important when ICBMs and SLBMs were developed. The multiple reentry vehicle and multiple independently targetable reentry vehicles were outgrowths of the development of smaller, lighter warheads. The ratio of yield-to-weight may be taken as a measure of the efficiency of nuclear weapons. However, inasmuch as some weight in a warhead must be devoted to non-nuclear materials (e.g., safing, arming, fuzing, and firing (SAFF) system), there is some practical limit to the efficiency of nuclear warheads which is below the theoretical conversion of the entire mass of the warhead to energy. The space and shape available for the warhead, which may affect yield, are constrained by the reentry vehicle design and size. The closer that a nation can come to the theoretical yield-to-weight relationship the higher their state of technology and the more flexibility that nation may have in warhead and reentry vehicle design.

2. Measure. This appendix addresses one such measure: Strategic Missile Warhead Yield-to-Weight Comparison. (U)

a. (U) What it Measures. This measure illustrates the relationship of warhead weight and yield for selected current US and USSR strategic missile systems and compares these to two theoretical limits. The measure is thus an indication of the state of the art of nuclear warhead technology in currently deployed missile systems. The standard comparative graphic technique used elsewhere in this report has not been used for several reasons. A limited data set was available, and these data are not directly comparable because of differing weapon yields and dates of development. For that reason, both individual data points and a fitted curve are illustrated in Figure A-1, which is described below.

The figure was constructed by plotting warhead yield in kilotons as a function of warhead weight. Dots (•) are used to represent US warheads

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and squares (■) to represent Soviet warheads. A parabolic curve was then fitted mathematically to both sets of data using a least squares curve fitting technique. The solid line represents the US and the dashed line the USSR.

In addition, two other lines are shown. One of these represents an estimate of warhead yield-to-weight relationships of a high technology engineering limit. The other is predicated on the total conversion of mass to energy[1] considering conversion of Li^6D at 28.9 KT/lb. The current warhead technology curves for both the United States and Soviet Union are approximately parallel to the " .: technology engineering limit" estimate for the range of comparable yields.

[1] (U) Potential Improvements in Soviet Technology and Their Implications for Civil Defense (U); System Planning Corporation, May 1975, pp. II-19.

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POPULATION AND MANUFACTURING VALUE ADDED (U)

1. (U) General. This appendix addresses potential targets of the US and USSR other than military forces. A strategic attack by either nation will cause casualties among the civilian population and damage to the economic resources of the other nation whether these were the prime targets or not. The number of casualties and amount of damage will vary greatly with target selection. Specific targets are not addressed and neither are long term effects caused by fallout nor residual radiation.

The method of presentation discussed in Chapter I, Section C, and utilized in most of this report is not used in this appendix. Rather the percent of the US and USSR population and Manufacturing Value Added (MVA)[1] are displayed as a function of the number of cities/urban areas.

2. Potential Targets. The capability of nuclear weapons to inflict massive destruction over large areas such as entire cities enables a nation to potentially attack not only military targets but also large portions of the civilian population and economic resources of another nation. (U)

a. (U) Population as a Target. The percent of the total national population in urban areas is one indication of the population at risk relative to the size of an attack. Equating cities to targets and comparing the percent of population relative to the number of cities (i.e., targets) provides a measure of the potential casualties.

Figure B-1, Percent of Population Versus Number of Cities, is a graphic representation of the population in the 1,000 most populous cities in both the US and the USSR based upon the 1970 Census of Population projected to 1975. The projections considered such factors as rate of growth and migration.

[1]Manufacturing Value Added (MVA) is defined as the output value of an industry minus the value of materials, utilities, and other services included in the product or consumed during production.

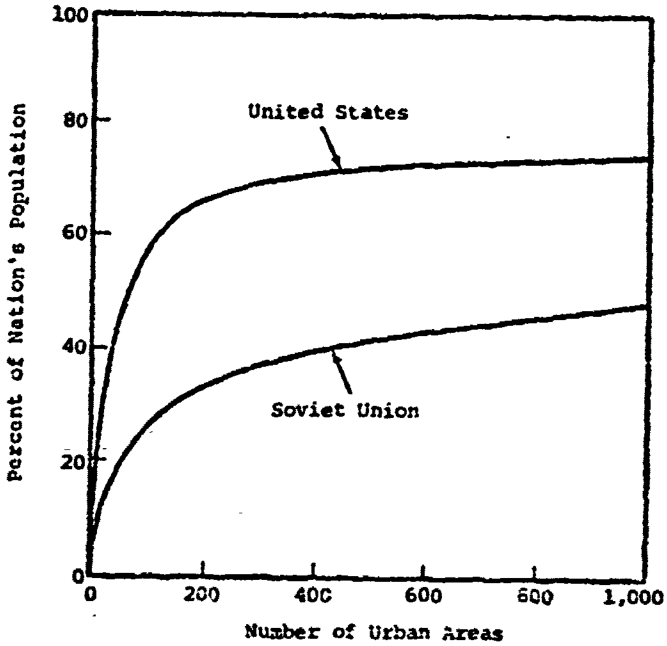

Figure B-1 Percent of Population Versus
Number of Urban Areas

For the US, an urban area is defined as a Standard Metropolitan Statistical Area (SMSA) which contains a city and its surrounding counties. In the case of the USSR, the data available are for cities only, except for the ten most populated urban areas which are referred to as "urban agglomerations."[2] The differences in definition, and therefore census procedures and results, preclude directly comparable data.

This measure, simply being a census of urban areas, does not consider the size of each urban area or the density of the population over the area.

[2]1975 UN Demographic Yearbook, New York, 1976, pp. 271-273.

Further, the measure does not consider defensive or protective measures which may be taken. In addition, many of the urban areas in both countries are directly at risk due to their proximity to strategic nuclear forces or other military installations which may be targeted.

Figure B-2, Area with Respect to Number of Cities, compares the total land areas of the 250 most populous cities in the US and Soviet Union.

Figure B-3, Distribution of Population with Respect to Area, compares the percent of the national population in the 250 most populous cities with the total area of those cities.

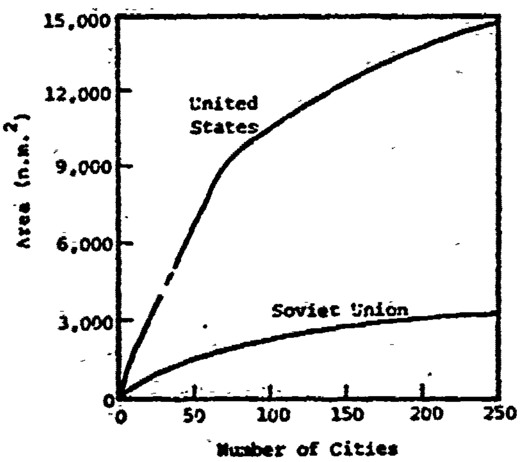

Figure B-2. Area with Respect to Number of Cities

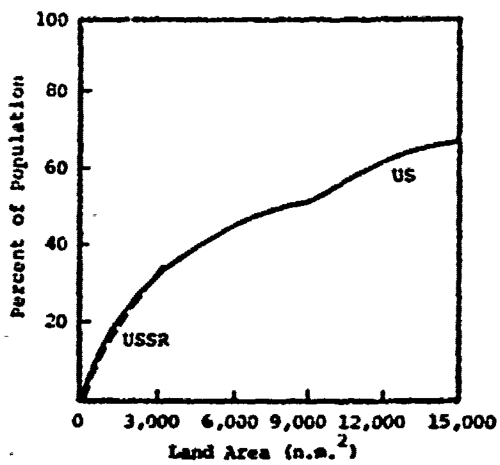

Figure B-3. Distribution of Population with Respect to Area

Depending upon weapon yield, many of the larger cities in both countries would require that multiple weapons be used against them. Even with this fact, due to the large number of multimegaton ICBMs in the Soviet inventory, the USSR could hold at risk more than 50% of the US population with approximately 250 weapons. (An average of about four 1.0 MT or larger warheads against each of 60 cities.) For the US to attack 50% of the Soviet population, it would require over 1,000 weapons.

b. Manufacturing Capability as a Target. The ability of a nation to recover from a nuclear attack and return to a position of world prominence is also at risk. Figure B-4 indicates that both countries have the capability of attacking over two-thirds of the total Manufacturing Value Added (MVA) of the other country by targeting 200 or less cities. (U)

(U) Although MVA is an economic indicator of industrial capacity, it has limitations in that it includes the manufacturing of commodities such as apparel, toys, and soaps, along with those industries associated with military and essential civilian production. The distribution of MVA, however, provides a measure of the number of cities which must be considered as potential targets in order to minimize industrial recovery.

(U) The ranking of the urban areas with respect to MVA is not necessarily in the same order as that with respect to population, particularly in the highest ranking cities. When the sample of urban areas becomes large (approximately 100), however, the same areas are included both in the set for population as well as for MVA.

(U) This measure, being the sum of MVA within a city or urban area, does not consider the dispersion of industry within the geographic area. The industrial capability may be concentrated in a small part of the city or spread out over a relatively large area. Also, there is no indication of the susceptibility of the industries to nuclear effects in terms of hardness, etc.

Figure B- Percent of Manufacturing Value Added (MVA)
With Respect to Urban Areas, 1976[a] (U)

[a](U) Urban areas are defined as standard metropolitan statistical areas for the US. In the USSR, an urban area is defined as an economic industrial concentration center.

(U) Current estimates of MVA for the US have an uncertainty or standard error of approximately 2% according to the Annual Survey of Manufactures 1976. The USSR values, however, are probably less reliable.

(U) As indicated above, there is no differentiation between the production of weapons and the production of items for civilian use. However, the measure does indicate that both nation's industry is highly centralized about a relatively few cities with 70% or more of the MVA attributed to 200 cities.

(U) APPENDIX C

TARGET.·G UNCERTAINTIES

1. General. In order to assess the probability of hitting a target using guided missile technology, one must have three categories of information:

- the relative position of the target with respect to the launcher,
- the gravitational effects along the flight path, and
- the performance criteria associated with the guidance system of the missile.

It is the intent of this appendix to explain some of the uncertainties associated with launcher and target positions which are used as inputs into the guidance system of the missile. From these positions along with a precise gravity model, factors such as launch angle, thrust, fuel required, vehicle reentry angle, and other trajectory parameters are computed in order to guide the missile to its target. Hardware accuracies associated with the guidance system itself are considered beyond the scope of this appendix.

The relative position of the target with respect to the launch site is required for trajectory, range, and direction computations. There are uncertainties associated with the launch position itself, the reference system used (an ellipsoid of revolution), and the position of the target. Both the launch site and the target must be positioned with respect to the same reference system in order to accurately compute range and direction. Therefore, any errors associated with any one of the three components (i.e., launch site, target position, and reference system) will increase the circular error probable (CEP) and probability of missing the target. Figure C-1 shows the interrelationships of these entities.

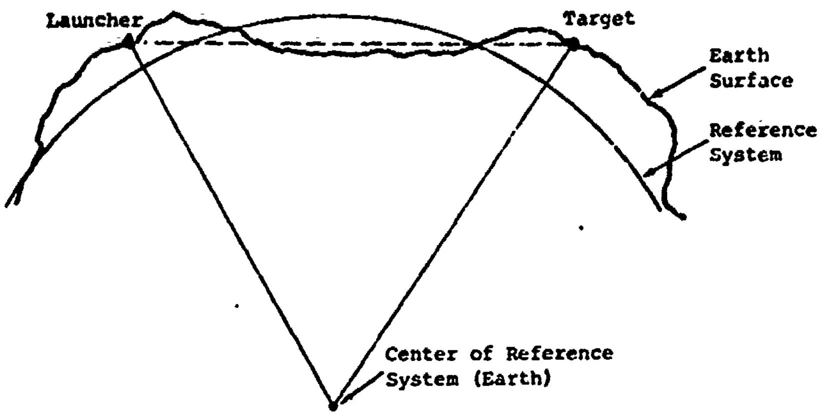

Figure C-1. Relationships of Launch Site, Target Position and Global Reference System

2. Launcher Position Uncertainties.

a. Land-Based Launchers. The accuracy of land-based launch site positions with respect to a reference system is dependent upon several factors:

- the density and geometry of the survey net around the launch site itself,
- the precision of the equipment used for the survey measurements, and
- the accuracy of the geodetic control points used in the survey data reduction and adjustment calculations.

In strategic weapon considerations, these land-based launch sites are considered fairly well determined and have a circular error probable (CEP) of a few feet with respect to the reference system used. Currently, the reference system used by the US for launcher and target positions is the World Geodetic System 1972 (WGS72).

b. Sea-Based Launchers. Sea-based launch sites present greater problems with respect to position than land-based sites. Current navigation techniques employ Doppler satellites in order to determine positions on WGS72. This requires a recent satellite pass in order to assess a ship's position

with any degree of accuracy. Today's navigation satellites can be observed from any given point in the ocean areas approximately every ninety minutes. Between passes, a submarine may move a significant distance from the location determined from the previous satellite pass. In these cases the current position of the ship is dependent upon the navigation hardware (accelerometers, gyroscopes, etc.) contained in the vessel. When the next navigation satellite passes, the ship's position may be updated or corrected.

3. Target Position Uncertainties. The position of a target, however, is more difficult to determine than that of the launcher due to the lack of accurate survey data in the area of the target. For strategic purposes and for many tactical artillery applications where launcher and target are not connected by conventional ground surveys, photogrammetric techniques have been developed to provide coordinates for unknown positions on the common reference system (WGS72). From an airborne station, a series of overlapping photographs are obtained producing stereoscopic pictures which are used for reconnaissance, planning, and target positioning. Land points are identified, measured directly on the photographs (in microns), and are used together with the camera parameters (height above ground and attitude angles) to derive the position of the points on the ground. Uncertainties in these positions derived through photogrammetry may be attributed to camera factors and external phenomena. Factors which introduce uncertainty pertaining to the camera are:

- lens distortions,
- spectral sensitivity of the film,
- focus of the lens system,
- the position of the camera in its flight path,
- the tilt angles of the camera at the instant the photograph is exposed.

External to the camera itself, other factors or phenomena may contribute to the reliability of the target positions. Among these are:

- atmospheric refraction (which bends the light ray paths),
- clouds,

- lack of control positions on which to base the photogrammetric adjustments,
- the ruggedness of the terrain being photographed.

In general, the flatter the terrain is, as in a desert, the more accurate are the coordinates of a point derived through photogrammetric techniques. It is more difficult, however, to accurately measure on a photograph a target in mountainous areas due to the resolution of the film itself. In this case, uncertainties increase in the position of the target, especially in the vertical component.

The uncertainties associated with relative target positions are greater in strategic missile cases than they are in tactical considerations due to the longer range between the launch site and the target. In the tactical cases where launcher and target positions are relatively close together, a photogrammetric data base may provide a high degree of reliability with respect to range and direction. Since launcher and target may appear either on the same pair of stereo photographs or on nearby exposures, the associated error is not allowed to accumulate and the relative positions of the two are considered more reliable.

4. Missile Flight Profile Uncertainties.

a. Gravitational. In addition to position and reference system uncertainties, the gravity model which is used to compute the flight path for the missile also may have errors which will decrease the probability of hitting the target. A representation of this concept is shown in Figure C-2.

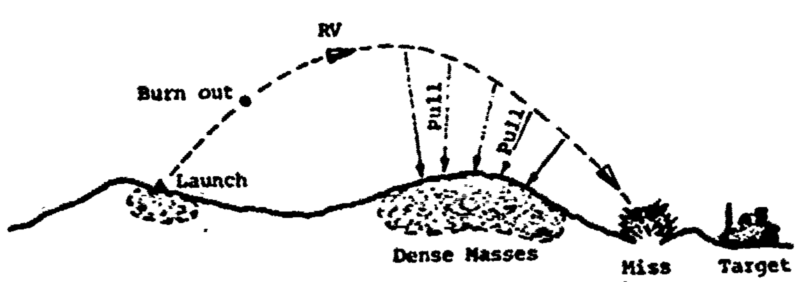

Figure C-2. Effects of Gravity on Missile Trajectory

When a ball is thrown into the air, it will eventually fall due to the gravitational attraction of the earth. Its path depends on the direction and power of the throw, which is overcome by the force of gravity. Likewise, the path of a missile depends upon the direction and power of the thrust, which also is eventually overcome by gravity. Any errors in the gravity model used will deflect the missile on its path to the target. During flight the missile is also subjected to known and unknown dense masses and may be pulled out of its computed trajectory, thus missing its target.

b. Other Factors. Although the previous paragraphs explain three major areas contributing to targeting uncertainty, other factors also contribute to the probability of hitting a target. Some of these include atmospheric turbulence along the flight path, the design of the missile itself, and air drag factors which are difficult to model. There are computer programs currently available which simulate these conditions and provide the analysts with an assessment of the error attributed to each type of variable. From these results, modifications to the missile itself or early flight path corrections may be performed to reduce the probability of missing the target.

STRATEGIC ARMS LIMITATIONS AGREEMENTS (U)

1. (U) General. The treaties, agreements, and understandings between the United States and Soviet Union on strategic weapons have been used in this report as a basis for present and future strategic projections. To date, the most instrumental agreement in limiting strategic nuclear forces is SALT I, which consists of the ABM Treaty, and the 1972 Interim Agreement and its Protocol. Additionally, the Protocol to the ABM Treaty was also significant in limiting strategic defensive systems. The understandings reached at the Vladivostok summit were important in providing a framework for the convening of SALT II. Collectively these agreements have had a significant effect on the development of strategic nuclear forces in both the United States and Soviet Union. In addition to these treaties, there have been some other agreements and treaties signed by the United States and Soviet Union which have further influenced nuclear force programs in both countries. These are the Limited Test Ban Treaty, Threshold Test Ban Treaty and its Protocol, and the Underground PNE Ban Treaty and its Protocol. The most relevant provisions of these treaties are outlined in paragraph 2.

2. (U) The Treaties and Agreements.

a. The ABM Treaty. The 1972 ABM Treaty was signed at Moscow by President Richard M. Nixon and General Secretary L. I. Brezhnev on May 26, 1972 and was entered into force on October 3, 1972.

The full title and key provisions are given below:

TREATY BETWEEN THE UNITED STATES OF AMERICA AND THE UNION OF SOVIET SOCIALIST REPUBLICS ON THE LIMITATIONS OF ANTI-BALLISTIC MISSILE SYSTEMS

- The United States and the Soviet Union are each limited to two ABM sites. The treaty permits each side to deploy one ABM site about its capital and another about an ICBM launch site.
- The two sites are to be at least 1,300 KM apart and so configured as to prevent the possibility of a regional or a nationwide defense system.

- At each site there are to be no more than 100 launchers and 100 interceptor missiles. The numbers and characteristics of radars are also limited.

- Qualitative improvements of ABM technology are to be limited. The treaty further prohibits improvement in surface-to-air missiles (SAMs) and their radars to preclude deployment against ICBMs and SLBMs.

b. The Interim Agreement and Protocol. The 1972 Interim Agreement and its Protocol were signed at Moscow by President Richard M. Nixon and General Secretary L. I. Brezhnev on May 26, 1972 and were entered into force on October 3, 1972.

The full titles and key provisions are given below:

INTERIM AGREEMENT BETWEEN THE UNITED STATES OF AMERICA AND THE UNION OF SOVIET SOCIALIST REPUBLICS ON CERTAIN MEASURES WITH RESPECT TO THE LIMITATIONS OF STRATEGIC OFFENSIVE ARMS

and

PROTOCOL TO THE INTERIM AGREEMENT BETWEEN THE UNITED STATES OF AMERICA AND THE UNION OF SOVIET SOCIALIST REPUBLICS ON CERTAIN MEASURES WITH RESPECT TO THE LIMITATIONS OF STRATEGIC OFFENSIVE ARMS

- The Interim Agreement is to remain in effect for 5 years, unless superceded earlier by a more comprehensive agreement.

- No new construction of ICBM launchers shall be undertaken after July 1, 1972.

- There shall be no conversion of "light" ICBMs to "heavy" ICBMs.

- Modernization and replacement of ICBMs is permitted, but in this process, the dimensions of the silo cannot be significantly increased (10-15% allowable).

- No new construction of SLBM launchers or SLBM-capable submarines shall be undertaken after the date of signing with the exception that:

  The US may increase to a ceiling of 710 SLBM launchers and 44 ballistic missile submarines from 656 SLBM launchers and 41 ballistic missile submarines by replacing 54 older (pre-1964) ICBM launchers.

  The USSR may increase to a ceiling of 950 SLBM launchers and 62 ballistic missile submarines from 740 launchers and 43 ballistic missile submarines by replacing older (pre-1964) ICBM launchers.

c. The ABM Protocol. The Protocol to the 1972 ABM Treaty was signed at Moscow by President Richard M. Nixon and General Secretary L. I. Brezhnev on July 3, 1974 and was entered into force on May 24, 1976. This Protocol further restrained deployment of strategic defensive armaments.

The full title and key provisions are given below:

PROTOCOL TO THE TREATY BETWEEN THE UNITED STATES OF AMERICA AND THE UNION OF SOVIET SOCIALIST REPUBLICS ON THE LIMITATIONS OF ANTI-BALLISTIC MISSILE SYSTEMS

- The United States and the Soviet Union are each limited to one ABM site. (This is a reduction from the two sites permitted in the ABM treaty proper.)

- Only one change is permitted in the location of the ABM site. Advanced notice must be given, and only in a year in which a review of the ABM Treaty is scheduled. The first review year begins on October 3, 1977 and is scheduled every 5 years thereafter.

d. The Vladivostok Summit. During their meeting at Vladivostok, President Gerald R. Ford and General Secretary L. I. Brezhnev agreed in principle upon the general terms which would form a basis for further strategic arms limitations negotiations. These terms were made public in the form of a joint United States-Soviet statement on November 24, 1974. The final numbers, given here in parenthesis, were released at a later date.

The full title and the key provisions are given below.

VLADIVOSTOK: LIMITATION OF STRATEGIC OFFENSIVE ARMS
JOINT UNITED STATES-SOVIET STATEMENT

- The United States and the Soviet Union reaffirm their intentions to conclude a new agreement on the limitation of strategic offensive arms. The new agreement will incorporate the relevant provisions of the Interim Agreement of May 26, 1972.

- The new agreement will cover the period from October 1977 through December 31, 1985.

- Strategic nuclear delivery vehicles will be limited to a certain aggregate number (2400).

- The number of ICBMs and SLBMs equipped with multiple independently targetable warheads will be limited to a certain aggregate number (1320).

- Mixing of ICBMs, SLBMs, and bombers under the overall ceiling on launchers is permitted.

- There will be no new ICBM silos or other fixed-site ICBM launchers allowed.

- There will be no conversions of "light" ICBMs to "heavy" ICBMs.

e. The Limited Test Ban Treaty. The Limited Test Ban Treaty was signed at Moscow on August 5, 1963 at the ministerial level, and was entered into force on October 10, 1963.

The full title and key provisions are given below:

TREATY BANNING NUCLEAR WEAPON TESTS IN THE ATMOSPHERE, IN OUTER SPACE AND UNDER WATER

- The parties to the treaty will not conduct any nuclear weapon test explosions, or any other nuclear explosions in the atmosphere, outer space, or under water.

- The treaty is of unlimited duration, with provisions for amendment and withdrawal.

f. Threshold Test Ban Treaty and Protocol. The 1974 Threshold Test Ban Treaty (TTBT) and its Protocol were signed at Moscow by President Richard M. Nixon and General Secretary L. I. Brezhnev on July 3, 1974.

The full titles and key provisions are given below:

TREATY BETWEEN THE UNITED STATES OF AMERICA AND THE UNION OF SOVIET SOCIALIST REPUBLICS ON THE LIMITATION OF UNDERGROUND NUCLEAR WEAPON TESTS

and

PROTOCOL TO THE TREATY BETWEEN THE UNITED STATES OF AMERICA AND THE UNION OF SOVIET SOCIALIST REPUBLICS ON THE LIMITATION OF UNDERGROUND NUCLEAR WEAPON TESTS

- Underground nuclear weapon tests exceeding a yield of 150 kilotons are prohibited, effective March 31, 1976.

- Compliance to the provisions will be assured through national technical means of verification.

- Underground nuclear explosions for peaceful purposes are exempt from the provisions of this Treaty.

- This Treaty will remain in force for a period of 5 years, unless succeeded earlier by a more comprehensive agreement.

- Certain technical data shall be exchanged on the geology and geography of nuclear weapons tests to assist verification of yields by national technical means.

- A separate understanding between the parties was concluded, which made provisions for occasional and unintentional violations of the Treaty.

9. Underground PNE Ban Treaty and Protocol. The Underground PNE Ban Treaty and its Protocol were signed in Washington and Moscow on May 28, 1976 by President Gerald Ford and General Secretary L. I. Brezhnev.

The full title and key provisions are presented below:

TREATY BETWEEN THE UNITED STATES OF AMERICA AND THE UNION OF SOVIET SOCIALIST REPUBLICS AND PROTOCOL TO THE TREATY ON UNDERGROUND NUCLEAR EXPLOSIONS FOR PEACEFUL PURPOSES

- Incorporating the terms of the test ban treaty, the parties have also agreed: not to conduct individual explosions having a yield in excess of 150 kilotons; not to carry out any group explosion having an aggregate yield exceeding 1,500 kilotons; not to carry out any group explosion having an aggregate yield exceeding 150 kilotons unless the individual explosions in the group could be identified and measured by agreed verification procedures.

- The parties are permitted to conduct peaceful nuclear explosions in the territory of another country if requested, but only if consistent with the terms of the Non-proliferation Treaty.

- Information and access to sites of explosion will be provided by each side.

- Provisions for the rights and functions of observers are set forth in detail.

- The Protocol addresses the procedures to be followed during the observation process, to include certain necessary privileges and immunities granted to observer personnel.

3. Force Limits and Actual Levels. The tables which follow show the 1972 Interim Agreement limits and the limits suggested at Vladivostok on the numbers and types of delivery vehicles. (U)

Pages D-6 and D-7 were Delet

(U) APPENDIX E

DERIVATION OF FORMULAS

1. General. This appendix considers the derivation of several important formulas--Equivalent Megatons, Single-Shot Probability of Kill, Counter Military Potential, and Hard Target Kill Capability.

2. Derivations.

a. Equivalent Megatons. Yield is related to the amount of damage that could be done to an urban-industrial target by a weapon. Yield, however, is directly proportional to blast volume and not to the area affected by the blast wave on the earth's surface (see Figure E-1). That is, in order to have a more valid measure of urban-industrial damage, it is necessary to relate yield to area of damage.

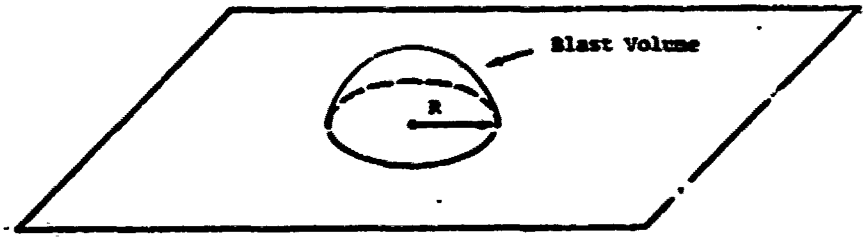

Figure E-1 (U). Blast Volume

Since the yield (Y) is proportional to the blast volume and the blast volume is proportional to the blast radius (R) cubed, it follows that yield is proportional to the blast radius cubed.

$$Y \propto R^3.$$

This relation then allows the blast radius to be expressed in terms of yield:

$$R \propto Y^{1/3}. \qquad (1)$$

The blast area (A) is related to blast radius by the standard area formula--i.e.,

$$A = \pi R^2. \qquad (2)$$

Combining equations (1) and (2),

$$A \propto R^2 \propto (Y^{1/3})^2.$$

Thus, the blast area is proportional to the yield to the two-thirds power:

$$\text{Blast Area} = K\,Y^{2/3}$$

where K is a proportionality constant.

The constant K is dropped, and when yield is expressed in megatons, the measure is called Equivalent Megatons.

$$EMT = Y^{2/3}.$$

Note: Because, except for a few large cities, yields in the megaton class can easily exceed the target size, a smaller exponent is often used for these large weapons. This is an attempt to discount the blast region beyond the target area.

b. <u>Single-Shot Probability of Kill</u>. When calculating the probability of destruction of a hard target, it is assumed that the warheads fall in a circular normal distribution about the target. Mathematically, this is expressed as:

$$P = e^{-ar^2}$$

where: r is the radius from the target, and a is a constant which specifies the spread of the distribution.

It is further assumed that the warhead has a "cookie-cutter" damage function. That is, if the warhead lands within the lethal radius (LR) of the target, as determined by the yield of the weapon and the hardness of

the target, then the target will be destroyed. Therefore, given the radius in which one-half of the warheads will fall (CEP), the probability that the target will survive (that the warhead will fall outside the lethal radius) is:

$$P_s = e^{-\ln(2)(LR/CEP)^2}. \tag{3}$$

The lethal radius can be assumed to be the product of some function of hardness (f(h)) and the blast radius. As can be seen from the derivation of EMT, the blast radius is proportional to the yield of the weapon to the one-third power. Thus:

$$LR = f(h)Y^{1/3}.$$

Since yield is in megatons, $f(h)$ is the lethal radius of a one megaton weapon of a target of hardress h.

Equation (3) becomes:

$$P_s = e^{-\ln(2)\left(\frac{f(h)\ Y^{1/3}}{CEP}\right)^2}$$
$$= e^{-\ln(2)\ f^2(h)(Y^{2/3}/CEP^2)}. \tag{4}$$

Since, by definition, $CMP = Y^{2/3}/CEP^2$, equation (4) may also be written as

$$P_s = e^{-\ln(2)\ f^2(h)\ CMP}$$

or, letting $g(h) = \ln(2)\ f^2\ (h)$, $P_s = e^{-g(h)CMP}$.

One approximation[1] to the lethal radius of a one megaton weapon is:

$$f(h) = \frac{h}{16}^{-1/3}.$$

[1] Another approximation is $f(h) = (0.068h - 0.23\ h + .19)^{-1/3}$.

Equation (4) becomes then:

$$P_s = e^{-\ln(2)CMP(h/16)^{-2/3}} .$$

Finally, the single shot probability of kill (P_k) is:

$$P_k = 1 - P_s$$

or

$$P_k = 1 - e^{-\ln(2)CMP(h/16)^{-2/3}}$$

or

$$P_k = 1 - 0.5^{(CMP/(h/16)^{2/3})} .$$

Note: There are many other factors in determining the probability of hard target kill--e.g., shape of target, whether the target is vulnerable to overpressure or dynamic pressure, duration of the blast wave, etc.--which were not considered here.

c. Counter Military Potential. Counter Military Potential (CMP) is defined as:

$$CMP = \frac{EMT}{(CEP)^2} .$$

The usefulness of this formulation as a measure of counter-force damage potential can be seen by considering the following:

Given a target with a hardness h_o and two weapons to be used against it (detonated sufficiently far apart in time so as to exclude fratricide) with yields of Y_1 and Y_2 and accuracies of CEP_1 and CEP_2, respectively, then the probability of the target surviving each weapon separately is as follows:

$$P_{s_1} = e^{-g(h_o)\ Y_1^{2/3}/CEP_1^2} .$$

$$P_{s_2} = e^{-g(h_o)\ Y_2^{2/3}/CEP_2^2} .$$

The probability that the target will survive both weapons (P_s) is:

$$P_s = P_{s_1} P_{s_2}$$

$$= \left(e^{-g(h_o)Y_1^{2/3}/CEP_1^2}\right)\left(e^{-g(h_o)Y_2^{2/3}/CEP_2^2}\right)$$

$$= e^{-g(h_o)(Y_1^{2/3}/CEP_1^2 + Y_2^{2/3}/CEP_2^2)}.$$

Since $$CMP_1 = Y_1^{2/3}/CEP_1^2$$

and $$CMP_2 = Y_2^{2/3}/CEP_2^2,$$

$$P_s = e^{-g(h_o)(CMP_1 + CMP_2)}.$$

Thus the advantage of CMP is that a simple summation of CMP values can be used to determine the probability of kill ($P_k = 1 - P_s$) of a target against which multiple warheads are used. In a rough sense, therefore, the more total CMP a force has the greater is its potential for destruction of hard targets.

NOTE: It is an unfortunate result, but a necessary one in terms of probability functions, that CMP tends to infinity as the accuracy becomes greater and greater--i.e., as CEP tends to zero. This is not a problem when CMP values are used in determining the probability of destruction of a single target. However, in the sense that CMP as a measure is used--i.e., the potential of multiple weapons against multiple targets--the inclusion of even a single weapon with great accuracy can cause total CMP values to overstate the real destructive capability of a group of weapons as a whole.

d. Hard Target Kill Capability. Hard target kill capability is an expected value in the mathematical sense. That is, if the number of weapons available and the probability of kill for each are known, then it is expected that a certain number of targets will be destroyed.

For instance, given $N = 100$ weapons with $P_a = 0.9$ probability of arrival and detonation and probability of kill $P_k = 0.5$, then it is expected --i.e., if the experiment could be repeated many times then the mean average result would be--that 90 weapons will arrive and that of those arriving, 45 will each destroy a target.

That is:

$$\text{Arriving Weapons} = N \times P_a = (100) \times (0.9) = 90.$$

$$\text{Targets Destroyed} = (\text{Arriving Weapons}) \times P_k = (90) \times (0.5) = 45.$$

This could have been done all at once as:

$$\text{Targets Destroyed} = N \times P_a \times P_k = (100) \times (0.9) \times (0.5) = 45.$$

If there are a number of weapon systems, then they are summed.

So that: $$\text{Hard Target Kill Capability} = C = \sum_{i=1}^{\#\text{ of Systems}} N_i P_{a_i} P_{k_i}$$

where:

N_i = number of weapons in the i^{th} system,

P_{a_i} = probability of successful arrival and detonation of the i^{th} weapon system,

P_{k_i} = single shot probability of kill of the i^{th} system.

TACTICAL/THEATER NUCLEAR FORCES (U)

1. (U) Introduction. This appendix addresses tactical/theater nuclear-capable forces. A comparison of tactical/theater nuclear forces is much more difficult than one of strategic forces. Force structure, planning, tactics, and force posture all interact to dictate the number and types of nuclear systems to be developed and deployed. A force which is considered to be primarily defensive in nature may lean toward smaller yield shorter range weapons, while a force which is designed for the offensive may tend to have longer range, larger yield weapons.

To compare the total inventories of US and USSR tactical/theater nuclear forces tends to ignore the deployment of these forces. The USSR, while mainly deployed in the Soviet Western Military Districts and the Warsaw Pact nations, has an appreciable amount of its forces deployed along the Sino-Soviet border. On the other hand, the US, which is also heavily deployed in the European theater, maintains considerable forces in the US and the Pacific.

While all of the forces of either nation could conceivably be deployed to a single theater, it is highly unlikely that this would ever occur.

Additional difficulties are encountered in any comparison of tactical/theater nuclear forces. Some of these are:

- How many warheads are associated with each delivery system?
- Are there reloads readily available?
- Does every individual delivery system which is nuclear-capable have weapons assigned to it?
- Are all variants of a given system nuclear-capable?
- What are the characteristics of the system?
- For systems which have both a conventional and a nuclear capability, are the system characteristics the same in either role?
- What are the characteristics of the nuclear warhead?

2. (U) Types of Weapons.

a. United States. The US inventory of tactical/theater nuclear weapons consists of short range surface-to-surface missiles, artillery, surface-to-air missiles, bombs, and Atomic Demolition Munitions (ADM).

b. Soviet Union. The USSR inventory is essentially the same in general characteristics as that of the US with the addition of Medium Range Ballistic Missiles (MRBM) and Intermediate Range Ballistic Missiles (IRBM).

c. Strategic Forces. Both nations have large inventories of strategic nuclear weapons which could be used in a tactical/theater conflict. The potencial use of any of these weapons cannot be ruled out.

3.

Short Range Missile Launchers
Medium Range/Intermediate Range Ballistic Missile (MR/IRBM) Launchers
Nuclear-Capable Aircraft Excluding Long Range Strategic Bombers
Sea-Launched Cruise Missile Launchers. (U)

Page F-3 was Deleted.

SHORT RANGE MISSILE LAUNCHERS (U)

What it Measures. The number of short range missile launchers in the inventory of both the US and USSR is totaled. (U)

(U) Limitations. By combining all short range missile launchers into one total, the measure ignores individual system characteristics such as range, warhead yield, accuracy, mobility, etc.

The measure also disregards the reload capability of each system and number of warheads available.

Launcher location and redeployment capabilities are not considered.

(U) <u>Uncertainties</u>. The numbers of past and present Soviet missile launchers are known with reasonable accuracy. Future estimates have a greater uncertainty and are based upon US projections of Soviet force structure.

<u>Comment</u>. Comparisons of the systems in the two forces in 1977 are shown in Figures F-2 (Number of Short Range Surface-to-Surface Missile Launchers, 1977 Inventory) and Figure F-3 (Range Capability of Surface-to-Surface Short Range Missiles, 1977 Inventory). (U)

Figure F-3 indicates both the maximum and minimum range capabilities of the various systems. (U)

Pages F-6 and F-7 were Deleted.

NUCLEAR-CAPABLE AIRCRAFT EXCLUDING
LONG RANGE STRATEGIC BOMBERS (U)

What it Measures. The measure compares the total of all the aircraft which possess a nuclear delivery capability other than long range strategic bombers. (U)

Limitations. The measure includes all US Navy and Marine Corps A-4, A-6, and A-7 attack/fighter aircraft and all US Air Force F-4 fighter/attack aircraft. (U)

(U) The measure does not include long range bombers assigned to either the US Strategic Air Command (SAC) or the USSR Long Range Aviation (LRA) forces. These aircraft (the US B-52 and the Soviet BEAR and BISON) all could be used in tactical/theater roles.

(U) The measure does not consider individual aircraft capabilities such as range, speed, number of weapons carried, delivery accuracy, etc.

(U) Since the measure totals all nuclear-capable aircraft except long range strategic bombers, it is an indication of a total tactical/theater capability. However, due to the present deployment of both US and USSR forces, it is not a true measure of delivery capability in any one theater.

(U) Uncertainties. There is some uncertainty regarding the numbers of aircraft. This uncertainty is much greater for future years than past. There is a degree of uncertainty relative to the nuclear capability of a given aircraft type. Some models of aircraft may all be nuclear-capable while other models may have only a few so configured. In addition, not all nuclear-capable aircraft are assigned primary nuclear missions.

SEA-LAUNCHED CRUISE MISSILES LAUNCHERS (U)

What it Measures. This measure is a count of the number of sea-launched cruise missile launchers in the US and USSR inventories. (U)

(U) Counting launchers disregards individual characteristics such as range, yield, accuracies, reliability, etc.

(U) Uncertainties. There is uncertainty as to the number of Soviet launchers. There is also some uncertainty in the number of US launchers and the rate at which they will be deployed.

(U) Comment. The rapid rise in US sea-launched cruise missiles after 1979 is attributed to the US planned SLCM program.

STRATEGIC WEAPONS SYSTEMS (U)

1. (U) General. This appendix lists the characteristics of the US and USSR offensive strategic weapons systems used in this report. For ICBMs, the throw-weight, the number of reentry-vehicles (RVs), yield per RV, CEP, and hardnesses of the ICBM systems are listed. Additionally, the schedules for upgrading MINUTEMAN silo hardnesses and for the MK12A phase-in are presented. The SLBM characteristics listed are the number of RVs, yield per RV, CEP, and range. Finally, bomber weapons yields and accuracies and the bomber loadings assumed in this report are listed. These are nominal figures and were used force wide.

2. The Tables. The tables contained in this appendix are:

US ICBM Characteristics
MINUTEMAN Silo Hardness Upgrading Schedule
MK12A Phase-In Schedule
USSR ICBM Characteristics
US SLBM Characteristics
USSR SLBM Characteristics
US and USSR Bomber Weapons Characteristics (U)

Pages G-2 through G-6
were Deleted.

(U) APPENDIX H

GLOSSARY OF TERMS

AAW	Anti-Air Warfare
ABM	Anti-Ballistic Missile
ALCM	Air-Launched Cruise Missile
ASM	Air-to-Surface Missile
ASW	Anti-Submarine Warfare
BMD	Ballistic Missile Defense
Bus	See PBV
CEP	Circular Error Probable (indicator of weapon accuracy; it is the radius of a circle within which half of the warheads are expected to fall)
CMP	Counter Military Potential, also called "lethality"
EW/GCI	Early Warning/Ground Control Intercept
EMT	Equivalent Megatons
ICBM	Intercontinental Ballistic Missile (approximately 3,000- to 8,000-nautical mile range)
IRBM	Intermediate-Range Ballistic Missile (approximately 1,500- to 3,000-nautical mile range)
KT	Kiloton (equivalent to 1,000 tons of TNT)
LRA	Long-Range Aviation (Soviet Avitsiya Dalnovo Deistviya)
MIRV	Multiple Independently targetable Reentry Vehicle
MRBM	Medium-Range Ballistic Missile (approximately 600- to 1,500-nautical mile range)
MRV	Multiple Reentry Vehicle
MT	Megaton (equivalent to 1,000,000 tons of TNT)
MVA	Manufacturing Value Added
NATO	North Atlantic Treaty Organization
PBV	Post-boost Vehicle (vehicle that carries multiple reentry vehicles; generally known as "bus")
PNE	Peaceful Nuclear Explosion
PSI	Pounds Per Square Inch
PVO	Air Defense Forces (Soviet Protivo-Vozdushnoi Oborony Strany)
RV	Reentry Vehicle

SAC	Strategic Air Command (US)
SAL	Strategic Arms Limitation
SALT	Strategic Arms Limitation Talks
SAM	Surface-to-Air Missile
SLBM	Submarine-Launched Ballistic Missile
SRAM	Short-Range Attack Missile
SRF	Strategic Rocket Forces (Soviet Raketnyye Voyska Strategicheskogo Naznacheniya)
SSB	Ballistic Missile Submarine (diesel-electric)
SSBN	Ballistic Missile Submarine (nuclear)
SSP_k	Single Shot Probability of Kill
TAC	Tactical Air Command (US)
VN	Vulnerability Number (indicator of target vulnerability to blast effects)

(U) APPENDIX I

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